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DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

BEACH EROSION BOARD
OFFICE OF THE CHIEF OF ENGINEERS

WAVE AND
LAKE LEVEL STATISTICS
FOR LAKE ONTARIO

TECHNICAL MEMORANDUM NO. 38

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BEACH EROSION BOARD
CORPS OF ENGINEERS

MARCH 1953

FOREWORD

This is the third of a series of reports to be issued by the Beach Erosion Board under its General Investigations program to provide wave statistics for selected regions. The need for such data is evident, and it is planned ultimately to supply it by actual wave measurement for sufficiently long periods to establish the wave climate at many locations. Suitable instruments for that purpose have not yet been developed and even after they become available much time must pass before the records can attain statistical value. The production of wave statistics by "hindcast" technique, admittedly of presently indeterminate quantitative accuracy, will nevertheless provide the engineer with better wave data than have heretofore been available.

Thorndike Saville, Jr., author of the report, is a Hydraulic Engineer in the Research Division of the Beach Erosion Board under the supervision of Joseph M. Caldwell, Chief of the Division. At the time this report was prepared, the technical staff of the Board was under the general supervision of Colonel E. E. Gesler, President of the Board and R. O. Eaton, Chief Technical Assistant.

The author was aided in the study by Robert F. Dearduff, Hydraulic Engineer; by John C. Fairchild, and Francis W. Kellum in computations and compilations; in map reduction by Philip A. Brown, Edward L. Hoefftman, Duane E. Nelson, Joseph W. Rom, and Lloyd W. Zwingelberg; and in drafting by Wendell E. Reece. The report was edited for publication by Albert C. Rayner. Views and conclusions stated in the report are not necessarily those of the Beach Erosion Board.

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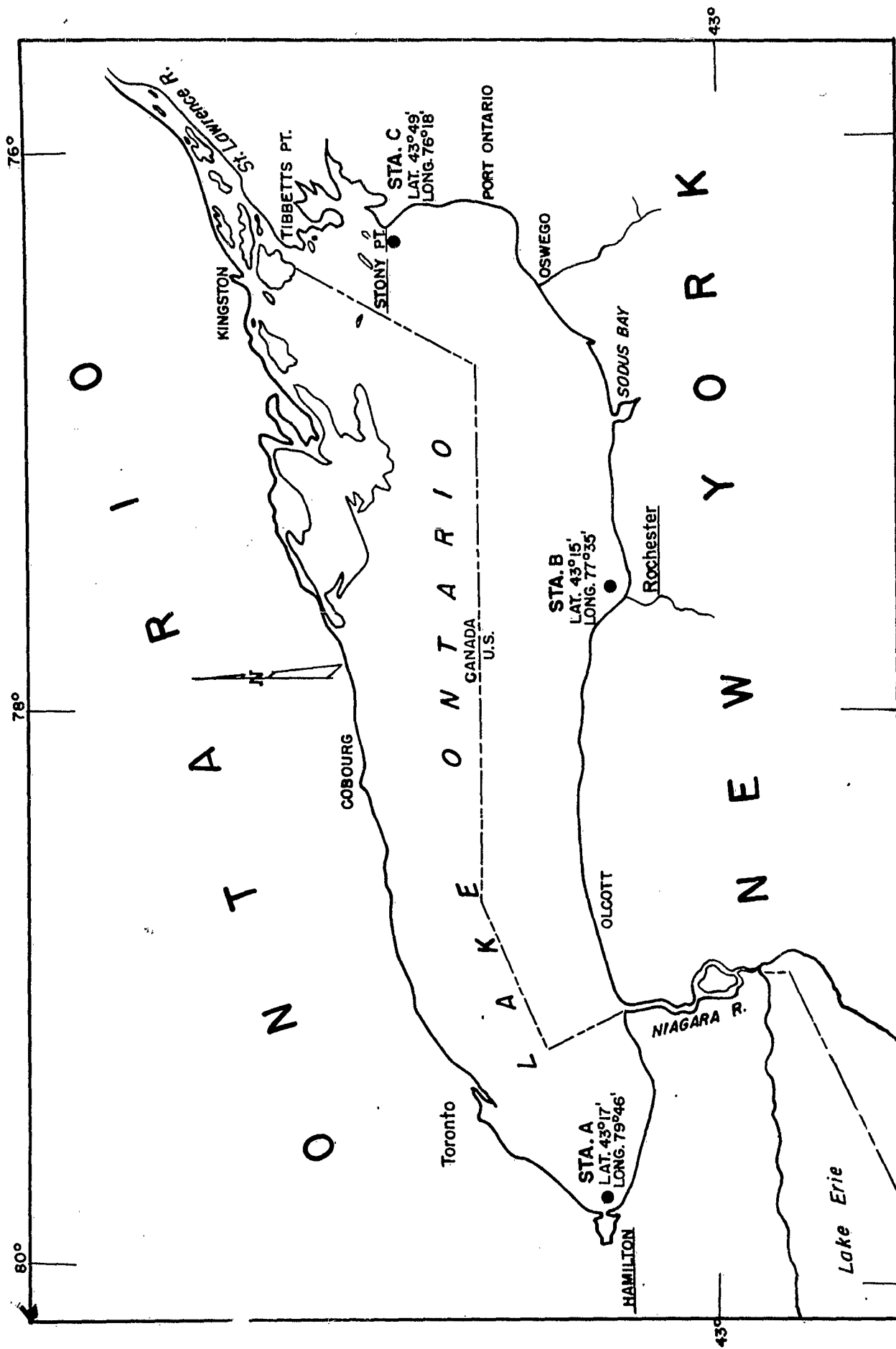


FIG.1 LOCATION OF WAVE HINDCASTING STATIONS FOR LAKE ONTARIO

WAVE AND LAKE LEVEL STATISTICS FOR LAKE ONTARIO

by

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INTRODUCTION

The General Investigations program of the Beach Erosion Board comprises investigations, regional rather than local in scope, designed to improve, simplify, and expedite the solution of local problems, by giving a compilation of all existing data pertinent to shore processes in the particular region. As a first step in the compilation of these data, a study of wave and lake level conditions on the Great Lakes is being made. The results of such a study for Lake Ontario are presented herein.

WAVE STATISTICS

Three stations on Lake Ontario were selected for a comprehensive wave analysis, the locations (see Figure 1) being as follows:

<u>Station</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Vicinity</u>
A	43° 17' N	79° 46' W	Hamilton, Ontario
B	43° 15' N	77° 35' W	Rochester, New York
C	43° 49' N	76° 18' W	Stony Point, New York

These particular stations were selected since it was thought that they would give adequate coverage to the entire lake shore of the United States, and permit interpolation of values between stations, thus giving an accurate representation of wave action at any point along the United States shore line of Lake Ontario.

Wave characteristics were determined from synoptic weather charts for each station for the three-year period 1948-1950. The weather maps used were the North American Surface Synoptic Charts compiled at six-hour intervals by the U. S. Weather Bureau. Fetch areas, and the wind speeds and durations in these areas, were determined directly from the weather maps; these values were used with the curves derived by Sverdrup and Munk (1)* and revised by Arthur (2) and later by Bretschneider (3)

* Numbers in parentheses refer to References on page 15.

to obtain the hindcast wave characteristics. The only major variation from the usual methods of wave forecasting or hindcasting (4) (other than that the new Bretschneider revised curves were used) was that the surface wind was determined directly from reported observations rather than from a gradient wind determined from the isobar spacing. It was thought that with the lake area so small in comparison to the area of the pressure cell, the isobaric pattern on the surface would be influenced to a large extent by the surface topography, and gradient winds determined from the isobar spacing would not necessarily give true values of wind velocity over the lake surface. Hence reported values of the surface wind could be expected to give a more realistic figure of the wind velocity. Observations have shown (5) that the greater surface friction serves to reduce the wind over land from what it may be over water. Since the reported values were almost always obtained at land stations, the wind speeds used in the analysis may have been lower than those actually occurring over the lake in the generating area. Some compensation was made for this by selecting the top speed of the Beaufort range reported rather than the middle value.

The wave characteristics thus determined are for the significant wave -- that is, the period is that of the predominating waves, and the height is the average of the higher one-third of these predominant waves. These values are summarized for each station in Tables A-1 through C-1 (Appendices A through C). It should also be noted that the wave conditions in these tables are deep water conditions. They must be used in conjunction with refraction diagrams to obtain inshore values. The tables show, for each station, the number of hours' duration that deep water waves of any given height, period, and direction occurred during any month of the three-year period; and also for each month (as summations) the number of hours' occurrence of waves of any particular height and period exclusive of direction; the number of hours' occurrence of waves of any particular height and direction exclusive of period; and the total number of hours' occurrence of waves of any particular height.

As an example of the data presented, from Table B-1 (Table 1 for Station B) for the month of July, waves of 1 to 2-foot height and 3 to 4-second period from the west-northwest occurred for 12 hours during 1948, 12 hours during 1949, and 36 hours during 1950. Thus, waves of this category occurred for a duration of 60 hours during the three-year period and hence can be expected to occur for about 20 hours (on the average) during July of any year in the future. Waves of 1 to 2-foot height and 3 to 4-second period (from all directions) occurred for 156 hours over the three-year period, or an average of 52 hours per year. Waves of 1 to 2-foot height from the west-northwest (all periods) occurred for 66 hours over the three-year period, or an average of 22 hours per year. Waves of 1 to 2-foot height (all periods and all directions) occurred for 252 hours over the three-year period, or an average of 84 hours per year. Tables A-2 through C-2 show the summation of the values in Tables A-1 through C-1 for the entire year and are read similarly to those tables.

During much of the winter season, portions of the lake are covered with ice, and fetch areas are limited considerably. In addition, for a somewhat greater portion of the winter season, the coast area of the lake is covered with ice, and, even though waves are generated in offshore areas, they never reach the shore, being interrupted by the ice around the rim of the lake. No account of this effect of the ice was taken in the actual hindcasting of the waves, and the durations given for the various winter months are computed as though there were no ice on the lake, a fact that should be remembered in using these data.

From yearly records of lake and air temperatures, and the dates of opening and closing of the lake for navigation, an average ice-free period was determined. For Lake Ontario this appeared to run, on the average, from April through November, and the average ice-free period was determined as 1 April - 1 December for all three stations. A summation of the wave data for this ice-free period is shown in Tables A-3 through C-3. These tables are similar to Tables 1 and 2 and represent a summation of the values in Tables 1 for all months from April through November. The durations of waves of particular height and direction have also been tabulated as percentages of time for the three-year period and are shown graphically in the wave roses for the full year and also for the ice-free period in Figures A-1 through C-1. In these roses, as in all other curves contained herein, the durations are percentages of 365 days, for the ice-free period as well as the full year data.

Figures A-2 through C-2 show the total percentages of time that the wave height may be expected to be greater than any particular height throughout the year. They thus show the (average) total duration time of specific waves over the year. Two curves are shown, one based on the data gathered for the entire year, and the other on just the average ice-free period (April through November). For example, at Station B, the total duration of waves in excess of 10 feet in height during the ice-free period is expected to be 0.09 percent of the time; and 0.20 percent of the time during the full year. Hence waves 10 feet or higher can be expected to occur for a total duration of 18 hours ($0.002 \times 365 \times 24$) over the course of each year, and, of this, 8 hours ($0.0009 \times 365 \times 24$) will be during the ice-free portion of the year when the waves will be certain to reach the shore.

Figures A-3 through C-3 show the frequency with which storms resulting in waves higher than a given height can be expected to occur. For example, at Station B, on 0.64 percent of the days each year the waves may be expected to be ten feet or greater in height, and on 0.29 percent of the days they may be expected to reach this height during the ice-free portion of the year. Thus waves ten feet or higher may be expected to occur (on the average) $2\frac{1}{3}$ times each year (0.0064×365), or seven times every three years; of these occurrences, only one (0.0029×365) will be expected to occur during the ice-free portion of the year.

Combining the data obtained from graphs on Figures B-2 and B-3, waves ten feet and higher may be expected to occur at Station B slightly more frequently than twice each year, and the average duration of each storm will be about 8 hours. During the ice-free portion of the year, waves of ten feet and higher may be expected to occur only once, and the duration of this storm is also expected to be about 8 hours.

There are, in general, two methods of plotting points to obtain frequency curves such as those shown in Figures A-3 through C-3. One, based on the so-called theory of sampling, involves the assumption that the known period of record (three years) is a fair average sample of all similar three-year periods over an infinite number of years, and that therefore the largest storm of this three-year period is the median of all storms of the same class in all other three-year periods. This results in a frequency given by the following equation:

$$F = \frac{2N - 1}{2T} \times 100$$

where F = frequency (in percent) of the occurrence of storms equalling or exceeding the given storm

T = number of days of record

N = number of occurrences of a storm equal to or greater than the given storm

The second method essentially considers only the period of record, in which case the frequency becomes

$$F = \frac{N}{T} \times 100$$

Values of F are the abscissa of points on the frequency curve. Using the second equation above, the largest storm which occurred in the known three-year period would have an abscissa of .0914 percent and would represent the storm which would most probably occur once in three years, i.e., would be the "three-year storm", etc. But this would be contrary to the theory of sampling, where (above) the assumption is made that the largest storm in the known three-year period was the median of the largest storms in a long succession of three-year periods. Therefore, over a long period such as 300 years, it will be exceeded not 100 times, but 50 times; i.e., it is by definition not a "3-year storm", but a "6-year storm".

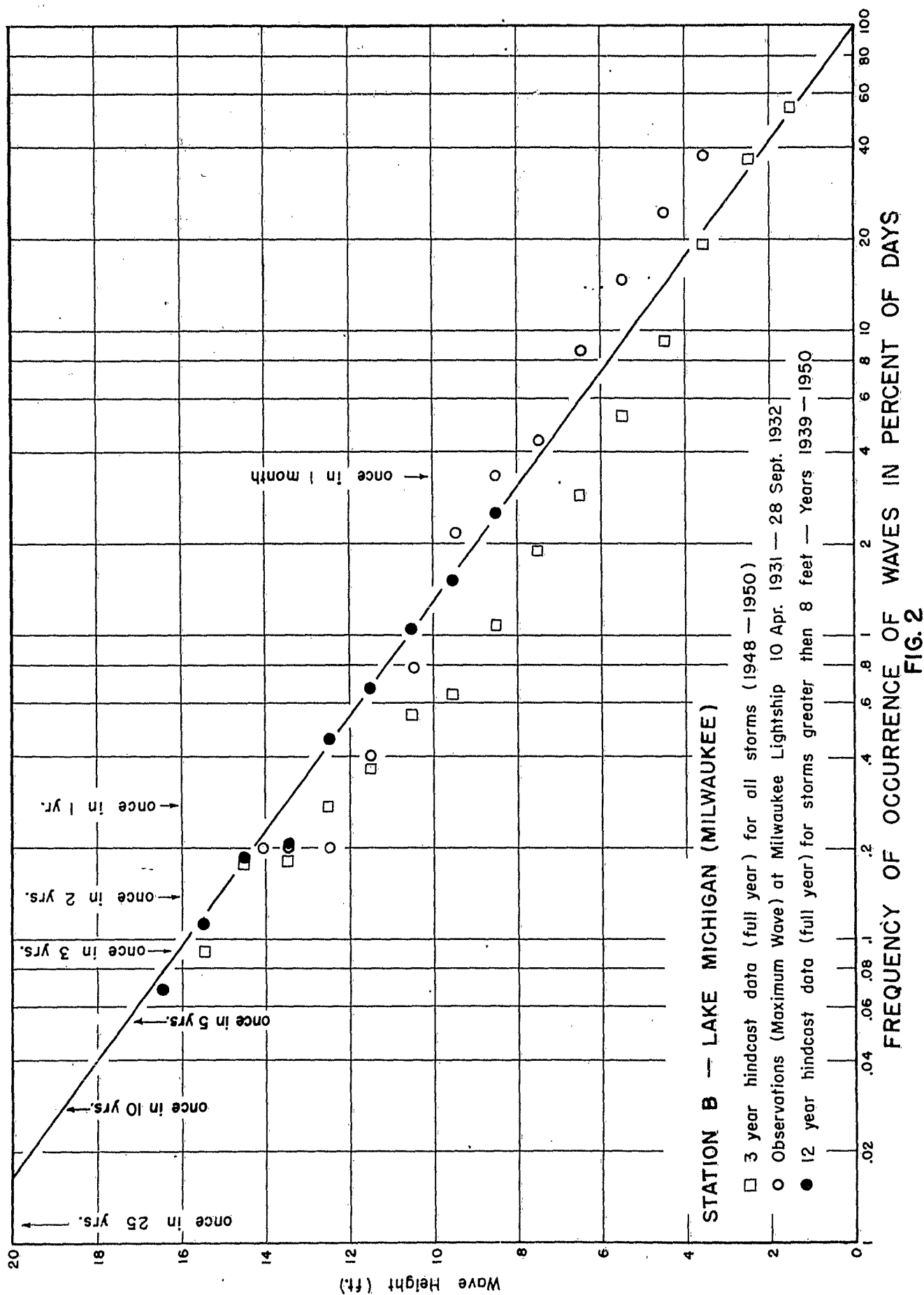
Either of the above two equations could be, and have been used to prepare frequency curves. Although the former is the one most generally used for hydrologic data, the latter method has been used in this case. The use of this formula ($F = 100N/T$) will result in a somewhat more conservative interpretation of the data, and was thought justified in view of the extremely short period of record (3 years).

The points plotted may be represented fairly closely by a continuous curve which frequently approximates a straight line, as may be seen from the figures. The curves shown have, in general, been drawn as lines of visual best fit; occasionally, however, more weight has been placed on the higher values. This tends to give a somewhat more conservative interpretation, which is thought warranted in some cases. The user is free to make his own interpretation of the plotted points. It is thought, also, that the very high waves occurring at Station A (Hamilton) may well represent storm waves of lesser frequency (particularly as there is a very sharp break and steepening of slope in the curve for the higher values), but due to the shortness of the period of observation this could not be determined.

In view of the shortness of the period of record some doubt arose as to the validity of extrapolation from these curves, and as to whether the three years chosen were representative (i.e., that they represent average conditions, and not three years of abnormally high, or low, waves). In a similar report, on Lake Michigan (6), hindcasts were made for one station for a period of 12 years (1939-1950) for all storms which were expected to give waves greater than 8 feet. The points determined were compared to those determined from the three-year data. These points fitted a straight line curve very closely and, though the points mostly lay slightly above those determined from the three-year data, the curve was not greatly different from that which had been drawn from the three-year data. Observations of the "average maximum" wave were obtained at this same station by the Milwaukee lightship over the period 10 April 1931 to 28 September 1932 (7) and these points were also compared to those hindcast. Although the exact correspondence between the significant waves hindcast and the "average maximum" waves observed is not known, values should be closely comparable -- and although the observed points lay somewhat higher for the lower waves, agreement was good for the higher waves. The comparison of these various points is shown in Figure 2.

Although comparisons were made for a station on Lake Michigan rather than on Lake Ontario, it is thought that the same degree of accuracy should be observed on Lake Ontario, and that therefore reasonable confidence can be put in the curves shown, at least for values of the waves occurring with frequencies less than about once in 10 years (with the possible exception of Station A).

Although for structural design purposes the important factor is the size of the maximum probable wave (within a certain time period), for computations involving sand movement and littoral drift, a more desirable parameter would be some averaged factor including within it the effect of both height and period, the variation of these parameters, and the duration that waves of each particular category exist. Present day knowledge indicates that sand movement by wave action is best correlated with the amount of energy transmitted forward (and eventually on to the beach) by the waves. The total energy per unit width in each wave is,



in deep water

$$E_o = \frac{wLH^2}{8} \left[1 - 4.93 \left(\frac{H}{L} \right)^2 \right] = \frac{wg}{16\pi} H^2 T^2 \left[1 - 4.93 \left(\frac{H}{L} \right)^2 \right]$$

where w = unit weight of water = 62.4 lbs./cu. ft.

g = acceleration due to gravity = 32.2 ft./sec./sec.

H = wave height (ft.)

T = wave period (sec.)

L = wave length (ft.)

One-half of this energy is transmitted forward from deep water toward the shore, and it is this amount of energy that eventually reaches the shore line. The total energy transmitted forward in any given period of time (E_T) is then $E_o/2$ times the number of waves occurring in that period of time,

$$\text{and } E_T = \frac{E_o}{2} \frac{(3600t)}{T} = 7.195 \times 10^4 H^2 T t \left[1 - 4.93 \left(\frac{H}{L} \right)^2 \right]$$

where t is the duration of the waves in hours. If some particular time interval (say one month) is considered during which waves of varying height and period pass a given point toward shore, then the heights and associated periods may be tabulated (as in Tables A-1 through C-1) and there will be n groups. If the height of the i th group is represented by its class mark \bar{H}_i , and the wave period in that group denoted by T_i , and the duration of the group by t_i , then the total amount of energy transmitted forward during the entire time interval is

$$E_T = E_{T1} + E_{T2} + E_{T3} + \dots + E_{Ti} + \dots + E_{Tn}$$

and

$$E_T = 7.195 \times 10^4 \sum_{i=1}^n \bar{H}_i^2 T_i t_i \left[1 - 4.93 \left(\frac{\bar{H}_i}{L_i} \right)^2 \right]$$

Tables A -4 through C-4 show a tabulation of the average energy transmitted forward from deep water toward the shore during the average ice-free period in each category of height, period, and direction. Thus for Station B, waves of 1 to 2-foot height and 3 to 4-second period from the west-northwest may be expected to transmit forward toward the shore 6214×10^4 foot-pounds per foot of wave crest during the ice-free period of each year. Waves of 1 to 2-foot height and 3 to 4-second period (all directions) would be expected to send forward $31,295 \times 10^4$ foot-pounds per foot of wave crest each ice-free period; waves of 1 to 2-foot height from the west-northwest (all periods) would be expected to send forward 7225×10^4 foot-pounds of energy per foot of wave crest; and waves of 1 to 2-foot height (all periods and directions) would be expected to

transmit toward the shore $37,214 \times 10^4$ foot-pounds of energy per foot of wave crest each ice-free period. Tables A-5 through C-5 show a similar tabulation for the average full year. Since the values in Tables A-1 through C-1 represent significant wave height and period, these energy values are those obtained if the wave system is uniform, and consists only of waves of significant height and period. Wave trains in nature are, however, exceedingly irregular, and have less energy than that determined by the significant wave concept. The relationship between the actual energy contained in any given wave train and that computed from the significant wave has been examined somewhat at Scripps Institution of Oceanography (8) and more recently by Barber (9) and Darbyshire (10), and has been found to be very nearly a constant ratio (on the order of 0.58). The energies given, therefore, may be considered to be the true value of the energy multiplied by some nearly constant value, and hence can be used to determine quite accurately ratios of energies from different directions. These latter represent very closely the ratios of the drift-producing forces. Summations of these energies for each direction and period grouping are shown in Figures A-4 through C-4.

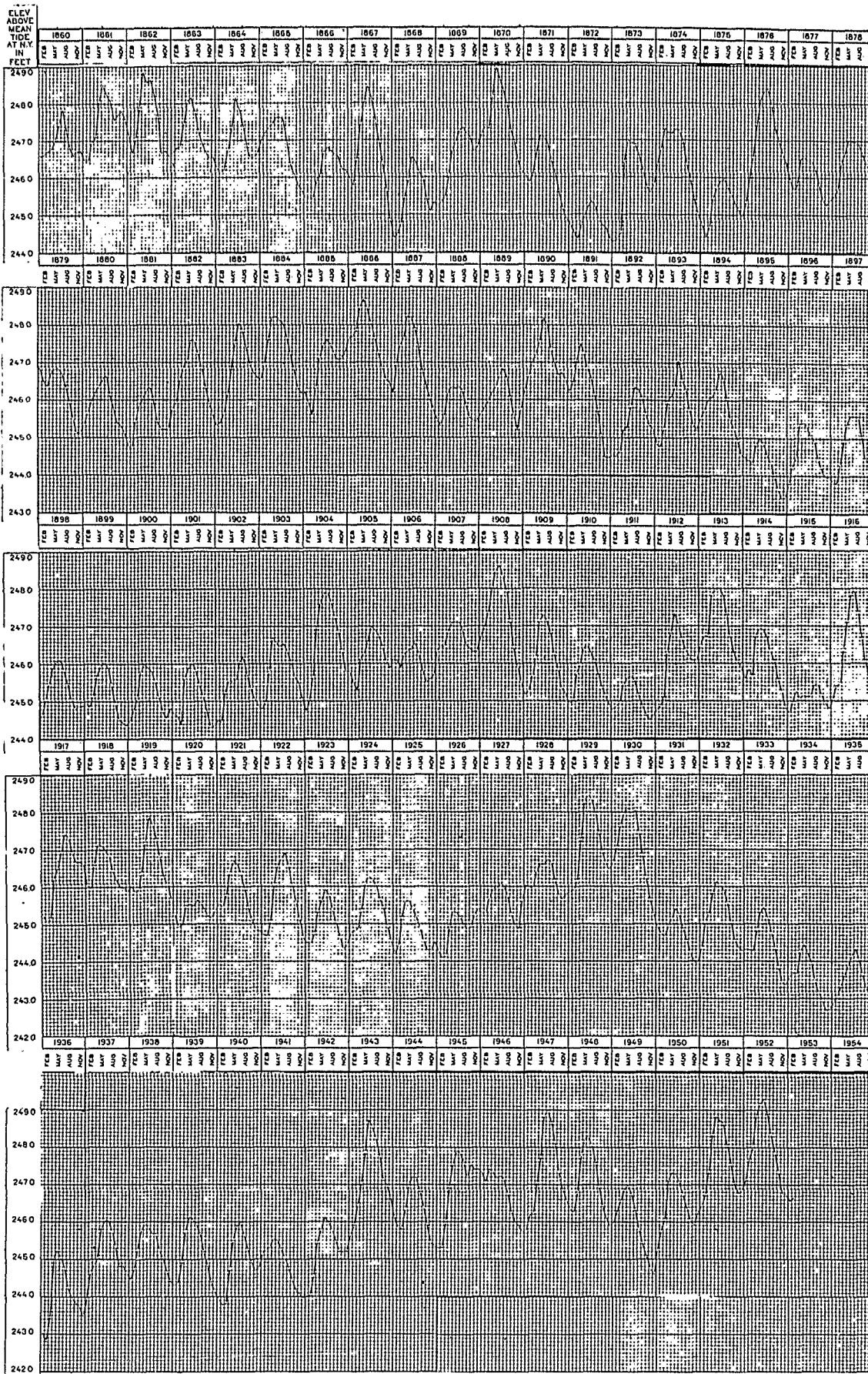
All the wave data given in the tables refer to deep water conditions--that is, depths greater than one-half the wave length. As such, interpolation between stations to obtain values for other points along the shore is quite valid, and it is felt that adequate deep water hindcast values may be thus obtained for all points on the United States shores of Lake Ontario.

Although the deep water data are useful for many types of design work, particularly for preliminary considerations, it is usually the inshore, shallow water data which are of the most interest. These data may be readily obtained from the deep water data through the use of refraction diagrams. A partial example for Ludington Harbor on Lake Michigan has been worked out and presented in the publication dealing with wave statistics on that lake (6), to which the reader may refer if unacquainted with the techniques involved.

LAKE LEVELS*

The levels of the Great Lakes fluctuate from year to year and from month to month during each year, depending upon the volume of water in the lakes. Continuous records of lake levels have been kept by the Corps of Engineers since 1860. A summary of these records for Lake Ontario is shown in Figure 3 which is a hydrograph of the monthly average levels from 1860 to date. The monthly average was chosen to eliminate the effects of short period barometric or wind-induced changes in stage. For Lake Ontario, the average level during the period of record (1860-1952) was 246.00 feet (above mean tide at New York, 1935 Datum) the highest one-month average of 248.97 occurring in May 1870 and July 1947 and the lowest of 242.68 occurring in November 1934. The difference between the highest and lowest monthly average levels is thus 6.29 feet, although the seasonal variation usually ranges between one and two feet

*Much of the following data on lake levels is taken almost verbatim from an unpublished report by the Great Lakes Div., Corps of Engrs., entitled "Preliminary Examination Report on Property Damage on the Great Lakes" issued in June 1952 (11).



MONTHLY MEAN WATER LEVELS OF LAKE ONTARIO
DATA COMPILED BY U.S. LAKE SURVEY, CORPS OF ENGINEERS
FIG. 3

(having an average range of 1.8 feet). The greatest range in level in a single season between the high and low month was 3.5 feet, and the lowest was 0.3 feet. The usual pattern of seasonal variation shows high levels in the summer and low levels in late winter (Figure 4). The highest monthly average level is usually reached in June and the lowest in January, though occasionally seasonal fluctuations have departed greatly from this usual pattern.

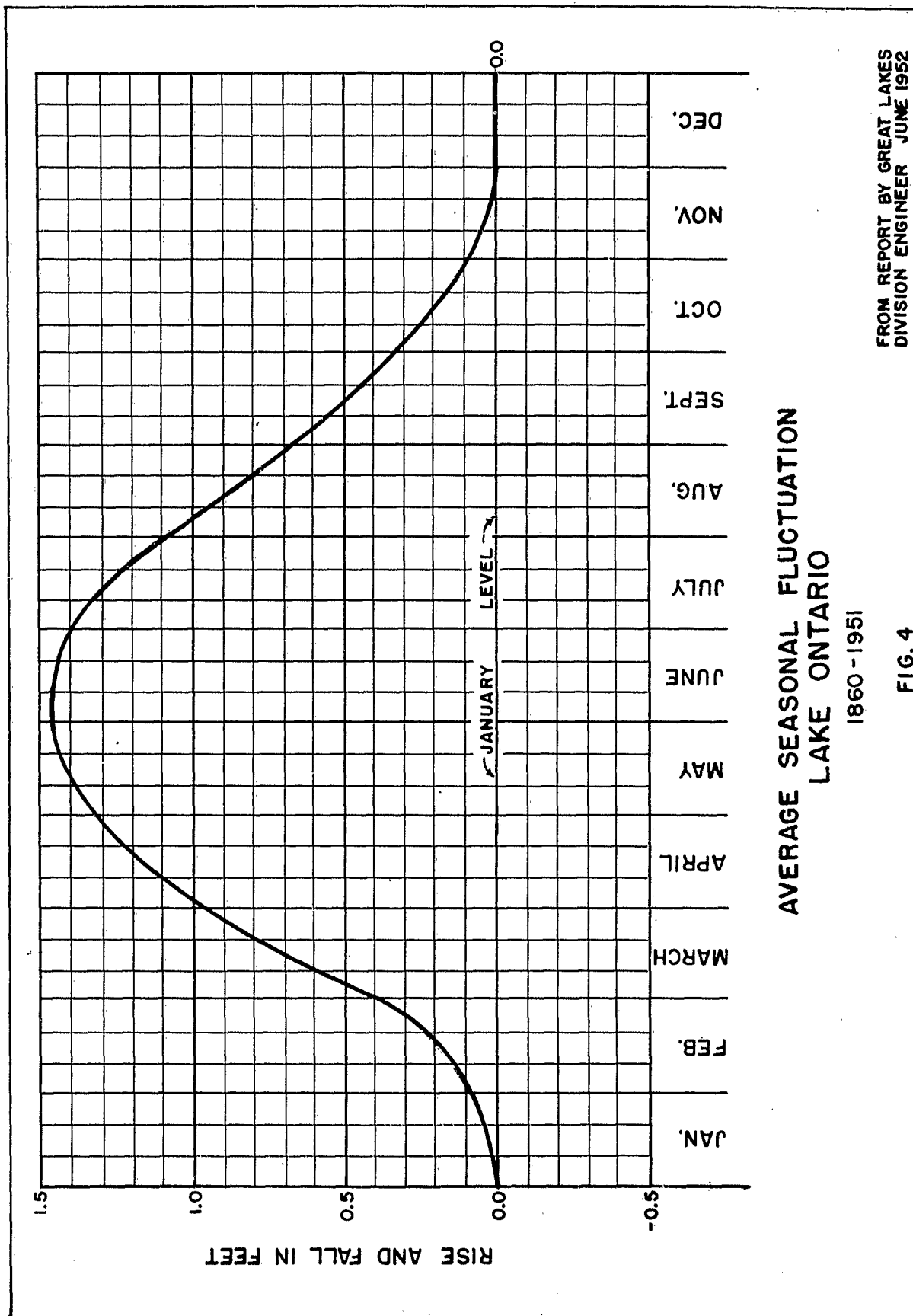
Figure 5 shows the percentage of time that the seasonal high average monthly level reaches various elevations on Lake Ontario for single, two, three, four, and five consecutive years. For example, it shows that the high monthly average each year reached elevation 245 feet or higher 97 percent of the time, reached elevation 246 feet or higher 80 percent of the time, reached elevation 248 feet or higher 20 percent of the time, and so on. It also shows that while the high monthly average level reached 246 feet or higher 80 percent of the time in single years, it reached this elevation only 70 percent of the time in two consecutive years, only 62 percent of the time in three consecutive years, only 51 percent of the time in four consecutive years, and only 46 percent of the time in five consecutive years.

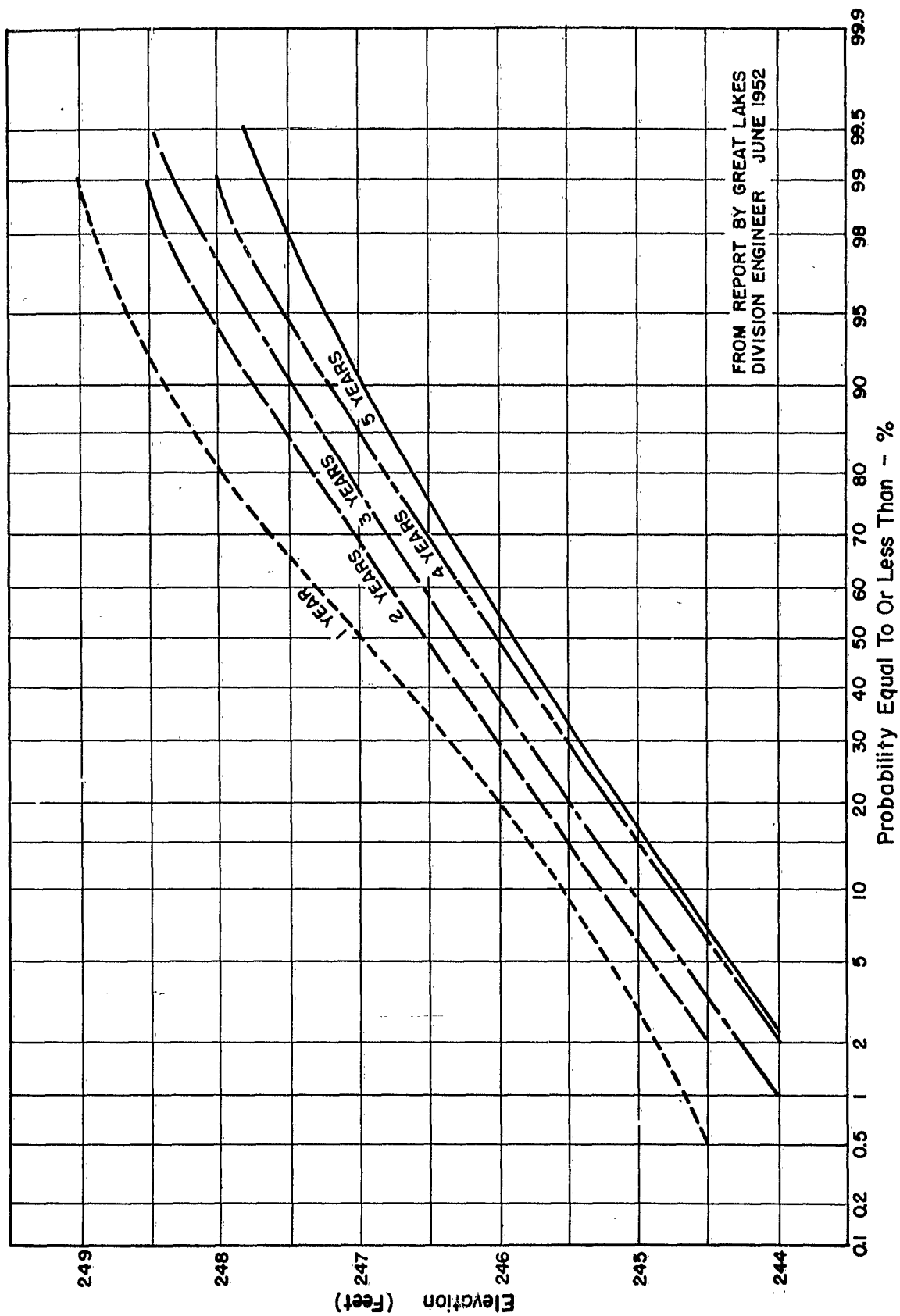
Superimposed on the long range and seasonal fluctuations resulting from the actual quantities of water present in the lake, are daily and even hourly fluctuations resulting from an unbalance or tilting of the lake surface. These are induced primarily by winds, though some have attempted to ascribe them to differential barometric pressures. Figure 6 is derived from data given in a report by the Great Lake Division Engineer (11) and shows the frequency of occurrence of short-period fluctuations at various gage sites on Lake Ontario during the period of record. Short-period rises at intermediate points between gage sites depend upon local conditions, but reference to the figures for points in the vicinity will provide an indication of the rises to be expected.

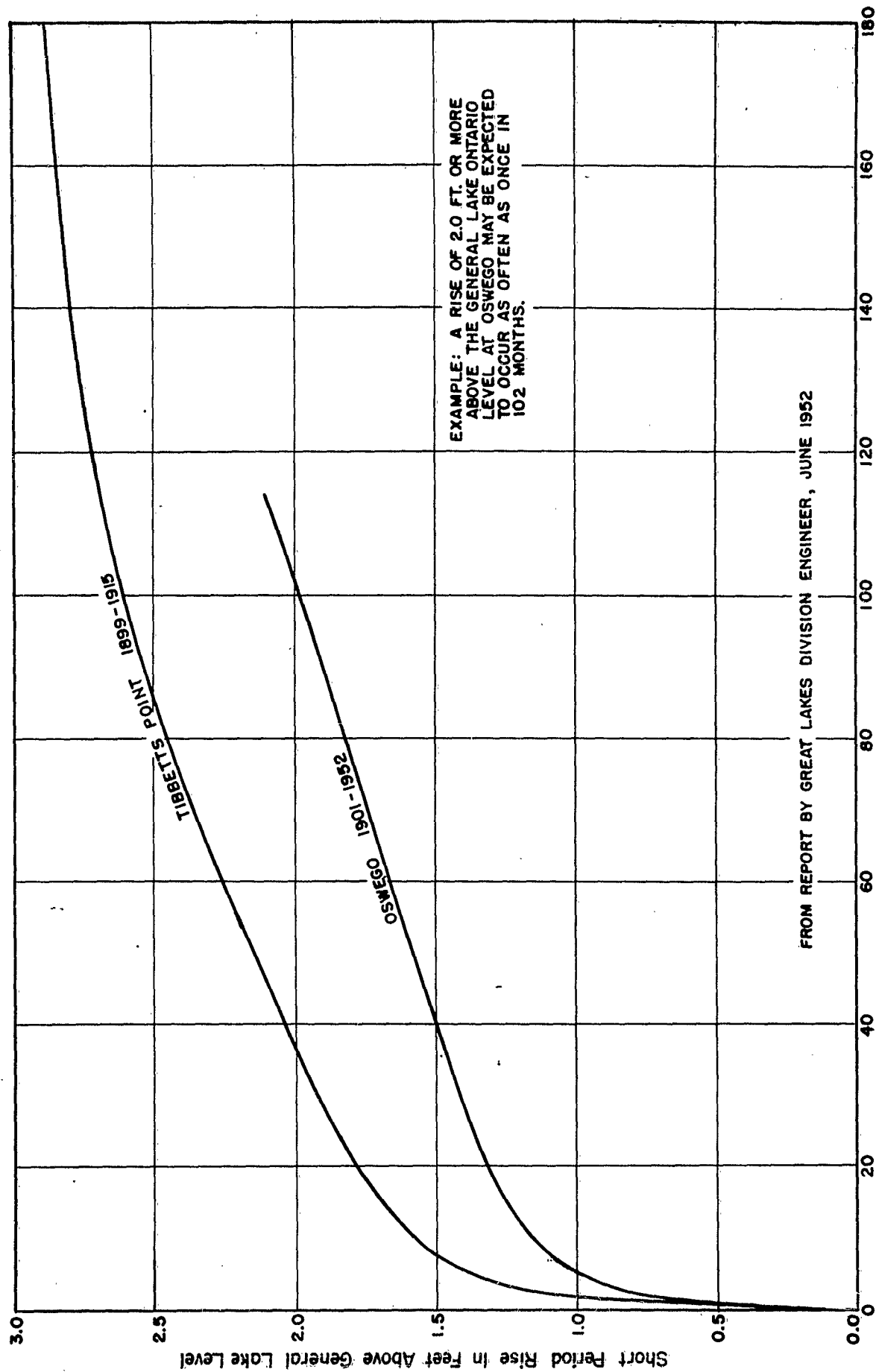
It has been found (12)(13) that, at least for shallow water areas, the rise in level due to wind stress may be predicted quite accurately by the formula

$$S = 1.165 \times 10^{-3} \frac{V^2 F}{D} N \cos \alpha$$

where S is the total set-up (difference in water surface elevations at the windward and leeward sides of the lake) in feet, F is the fetch length in statute miles, V is the average wind velocity over the fetch in miles per hour, D is the average depth in feet of that portion of the lake that is more or less contiguous to the fetch, α is the angle between the wind and the fetch, and N is a shape coefficient dependent on the planform and nearshore hydrography of the particular area. Though methods of computing N are available, unless the area is a very marked convergent bay, it is usually sufficient to assume values of $N = 1$. The actual rise in water surface elevation above still water level will







FREQUENCY OF OCCURRENCE - SHORT PERIOD FLUCTUATIONS
TIBBETTS POINT & OSWEGO - LAKE ONTARIO
FIG. 6

be slightly greater than $S/2$ depending on the nearshore hydrography; an average value of 0.57 has been in general use, and is quite adequate. Although this formula has been checked quite adequately for shallow areas (experimental tanks, the Zuider-Zee, and Lake Okeechobee) extension to deeper waters, as Lake Ontario, may be unwarranted, and it should be used with some caution.

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WAVE AND LAKE LEVEL STATISTICS

FOR

LAKE ONTARIO

APPENDIX A

WAVE STATISTICS

FOR

STATION A

HAMILTON, ONTARIO

JANUARY

FEBRUARY

MARCH 2

636	666	672	1974
744	744	744	2232

TABLE A-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION A, HAMILTON, ONTARIO
Duration given in hours. Height and period groupings include lower value but not the upper.
APRIL

Height (Feet)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
3-4	NE																								
	ENE																								
	E																								
	ENE																								
	NE																								
4-5	NE																								
	ENE																								
	E																								
	ENE																								
	NE																								
5-6	NE																								
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6-7	NE																								
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	E																								
	ENE																								
	NE																								
7-8	NE																								
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	E																								
	ENE																								
	NE																								
TOTAL		30	12	18	60	12	18	18	72	12	18	18	72	12	18	18	72	12	18	18	72	12	18	18	72
CALM																									
TOTAL HOURS																									

MAY

Height (Feet)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
3-4	NE																								
	ENE																								
	E																								
	ENE																								
	NE																								
4-5	NE																								
	ENE																								
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7-8	NE																								
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	ENE																								
	NE																								
TOTAL		12	24	30	96	24	36	66	126	30	18	24	72	24	24	96	72	24	24	96	72	24	24	96	72
CALM																									
TOTAL HOURS																									

JUNE

Height (Feet)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
3-4	NE																								
	ENE																								
	E																								
	ENE																								
	NE																								
4-5	NE																								
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	ENE																								
	NE																								
7-8	NE																								
	ENE																								
	E																								
	ENE																								
	NE																								
TOTAL		12	24	30	96	24	36	66	126	30	18	24	72	24	24	96	72	24	24	96	72	24	24	96	72
CALM																									
TOTAL HOURS																									

TABLE A-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION A, HAMILTON, ONTARIO
Duration given in hours. Height and period groupings include lower value but not the upper.
JULY

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				2-6 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	NNE	6			6													6			6
	NE	6			6													6			6
	ENE	12	24		36													12	24		36
	E	6			6													6			6
	ESE	6			6													6			6
1-2	TOTAL	24	24		48													24	24		48
	N	6			6													6			6
	NE	6			6													6			6
	ENE	6			6													6			6
	E	6			6													6			6
2-3	TOTAL	18	18		36													18	18		36
	NNE																				
	NE																				
	ENE																				
	E																				
3-4	TOTAL																				
	NNE																				
	NE																				
	ENE																				
	E																				
4-5	TOTAL																				
	NNE																				
	NE																				
	ENE																				
	E																				
TOTAL		42	54	18	114	30	18	6	54	18	6	6	30	6	6	12	96	744	744	744	2232
CALM																		648	648	648	1944
TOTAL HOURS																					

AUGUST

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
1-2	NNE	6	6		12	6	18		24					6	24		30
	NE	6	12		18	6	12		18					6	12		18
	ENE	6	6		12	6	6		12					6	6		12
	E	6	6		12	6	6		12					6	6		12
	TOTAL	18	18		36	18	36		72					18	42		60
2-3	NNE					6	6		12					6	6		12
	NE					6	6		12					6	6		12
	ENE					6	6		12					6	6		12
	E					6	6		12					6	6		12
	TOTAL					12	12		24					12	12		24
3-4	NNE									12	12		24				24
	NE									6	6		12				12
	ENE									6	6		12				12
	E									6	6		12				12
	TOTAL									12	12		24				24
TOTAL		18	18	12	48	36	36		72	12	12		24	60	60		120
CALM																	
TOTAL HOURS																	

SEPTEMBER

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				2-6 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	NNE	6			6													6			6
	NE	6			6													6			6
	ENE	6			6													6			6
	E	6			6													6			6
	TOTAL	6			6													6			6
1-2	NNE					6	6		12									6			6
	NE					6	6		12									6			6
	ENE					6	6		12									6			6
	E					6	6		12									6			6
	TOTAL					12	12		24									12			12
2-3	NNE																				
	NE																				
	ENE																				
	E																				
	TOTAL																				
3-4	NNE																				
	NE																				
	ENE																				
	E																				
	TOTAL																				
4-5	NNE																				
	NE																				
	ENE																				
	E																				
	TOTAL																				
TOTAL		18	24	42	84	18	18		36	12	12		24	60	60		120	660	702	600	1962
CALM																					
TOTAL HOURS																					

OCTOMER

NOVEMBERDECEMBERA-4

Duration given in hours. Height and period groupings include lower value but not the upper.

TABLE A-3

Duration given in hours. Height and period groupings include lower value but not the upper.

A-5

TABLE A-4
STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION A, HAMILTON, ONTARIO
ICE-FREE PERIOD (1 APRIL - 30 NOV.)

Energy given in foot-pounds per foot of crest per year $\times 10^4$. Height and period groupings include lower value but not the upper

Height (Feet)	Period (Secs)	2-3 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds	8-10 Seconds	11-12 Seconds	13-14 Seconds
5-1	N	4.0								4.0
	NNE	12.1								12.1
	NE	18.2								18.2
	ENE	40.8								40.8
	E	18.2		3.6						21.8
1-2	ESE	6.1								6.1
	Total	9.0		3.6						12.6
	N	8.0	1.1							9.1
	NNE	6.1	9.0							15.1
	NE	12.1	30.0							42.1
2-3	ENE	9.1	39.9	11.6						60.6
	E	8.1	20.9	2.9		2.0				34.0
	ESE	4.0	4.5							8.5
	Total	24.5	105.0	14.5		2.0				140.0
	N		6.5							6.5
3-4	NNE		15.6							15.6
	NE		12.4	16.1						28.5
	ENE		12.4	8.0						20.4
	E		9.7							9.7
	Total		62.5	24.1						86.6
4-5	NNE		18.2	63.1						81.3
	NE		60.8	94.6						155.4
	ENE			53.2						53.2
	E		60.8	70.9	19.2					150.9
	Total		36.7	277.6	19.2					355.7
5-6	N			12.9						12.9
	NNE			79.8						79.8
	E			42.9						42.9
	Total			235.5						235.5
	N									10.8
6-7	NNE									10.8
	E									6.0
	Total									16.8
	N									2.3
	Total									2.3
7-8	N									2.3
	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
8-10	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
	Total									2.3
11-12	N									2.3
	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
13-14	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
	Total									2.3
TOTAL		48.5	204.0	36.4	7.4	2.0	14.7	32.0	86.9	240.6

TABLE A-5
STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION A, HAMILTON, ONTARIO
FULL YEAR

Energy given in foot-pounds per foot of crest per year $\times 10^4$. Height and period groupings include lower value but not the upper

Height (Feet)	Period (Secs)	2-3 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds	8-10 Seconds	11-12 Seconds	13-14 Seconds
5-1	N	4.0								4.0
	NNE	12.1								12.1
	NE	18.2								18.2
	ENE	40.8								40.8
	E	18.2		3.6						21.8
1-2	ESE	6.1								6.1
	Total	9.0		3.6						12.6
	N	8.0	1.1							9.1
	NNE	6.1	9.0							15.1
	NE	12.1	30.0							42.1
2-3	ENE	9.1	39.9	11.6						60.6
	E	8.1	20.9	2.9		2.0				34.0
	ESE	4.0	4.5							8.5
	Total	24.5	105.0	14.5		2.0				140.0
	N		6.5							6.5
3-4	NNE		15.6							15.6
	NE		12.4	16.1						28.5
	ENE		12.4	8.0						20.4
	E		9.7							9.7
	Total		62.5	24.1						86.6
4-5	NNE		18.2	63.1						81.3
	NE		60.8	94.6						155.4
	ENE			53.2						53.2
	E		60.8	70.9	19.2					150.9
	Total		36.7	277.6	19.2					355.7
5-6	N			12.9						12.9
	NNE			79.8						79.8
	E			42.9						42.9
	Total			235.5						235.5
	N									10.8
6-7	NNE									10.8
	E									6.0
	Total									16.8
	N									2.3
	Total									2.3
7-8	N									2.3
	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
8-10	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
	Total									2.3
11-12	N									2.3
	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
13-14	NNE									2.3
	E									2.3
	Total									2.3
	N									2.3
	Total									2.3
TOTAL		6.7	36.4	69.1	69.9	32.3	69.7	144.0	86.9	455.6

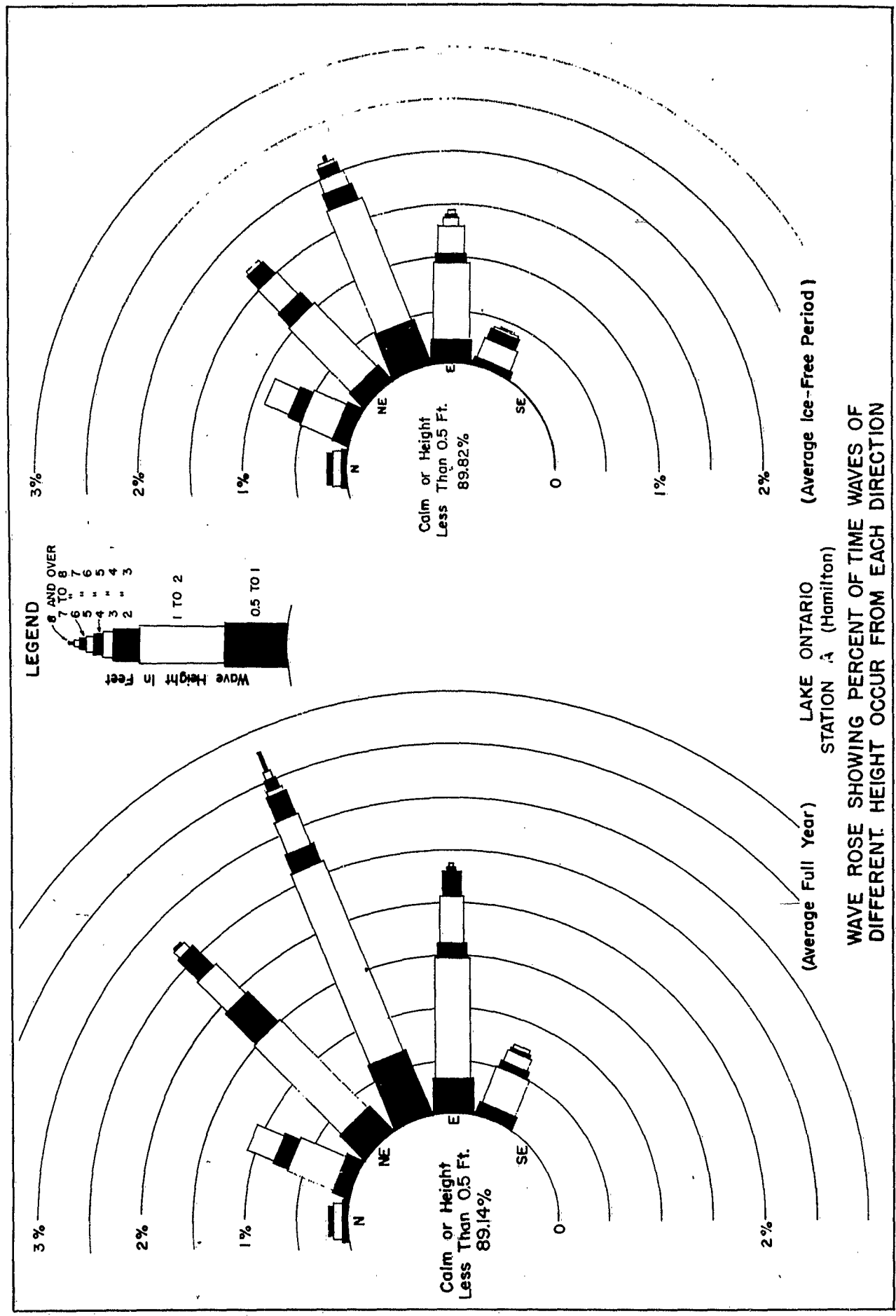
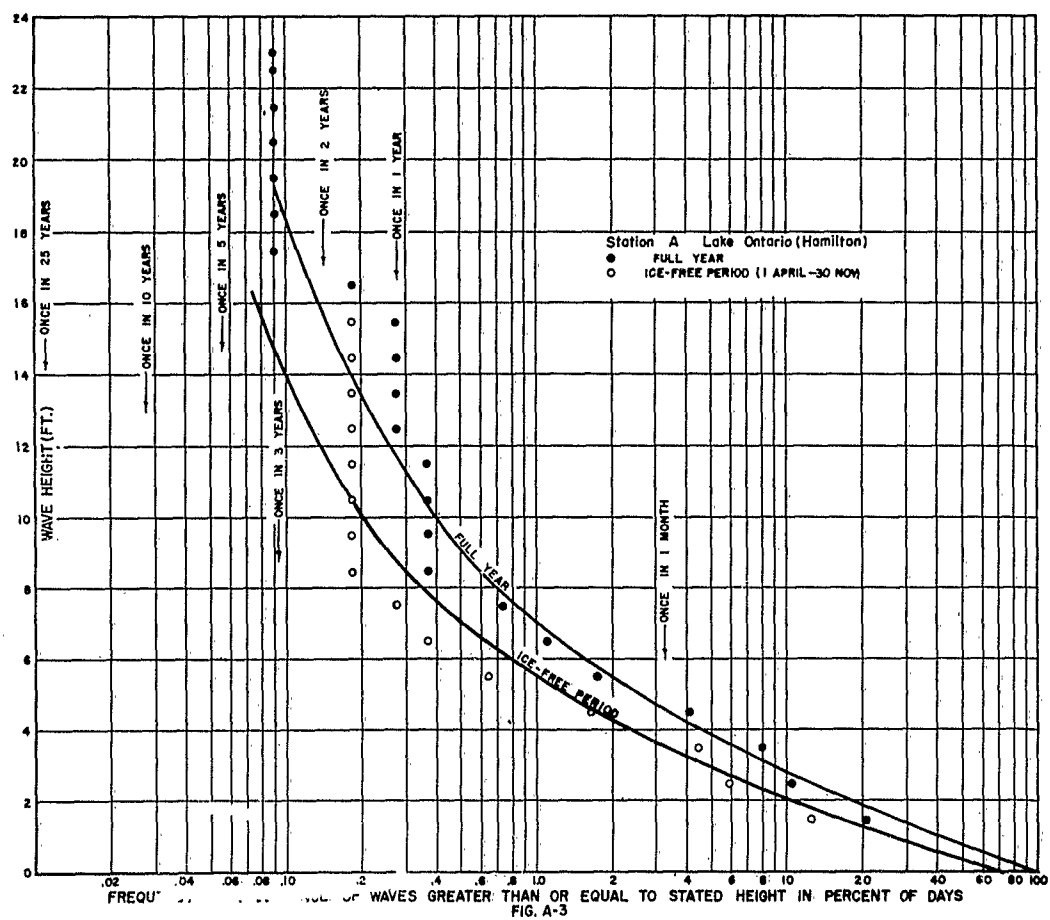
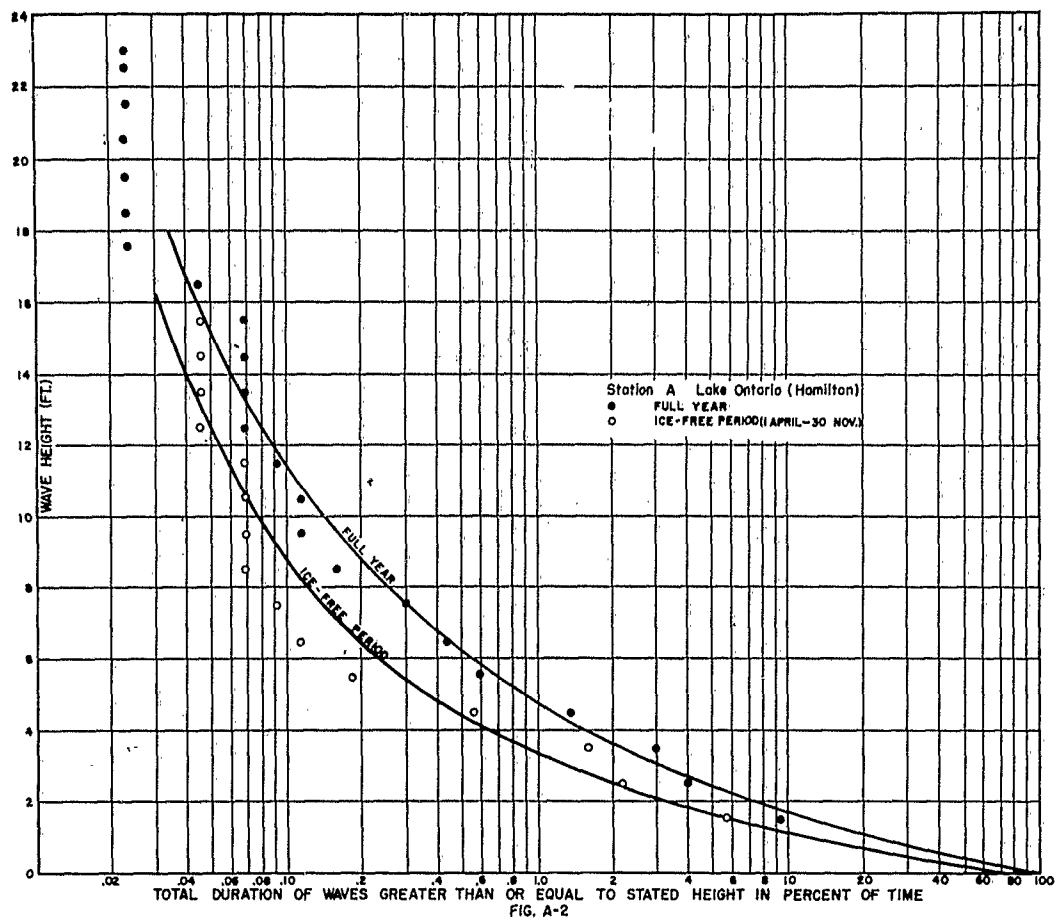
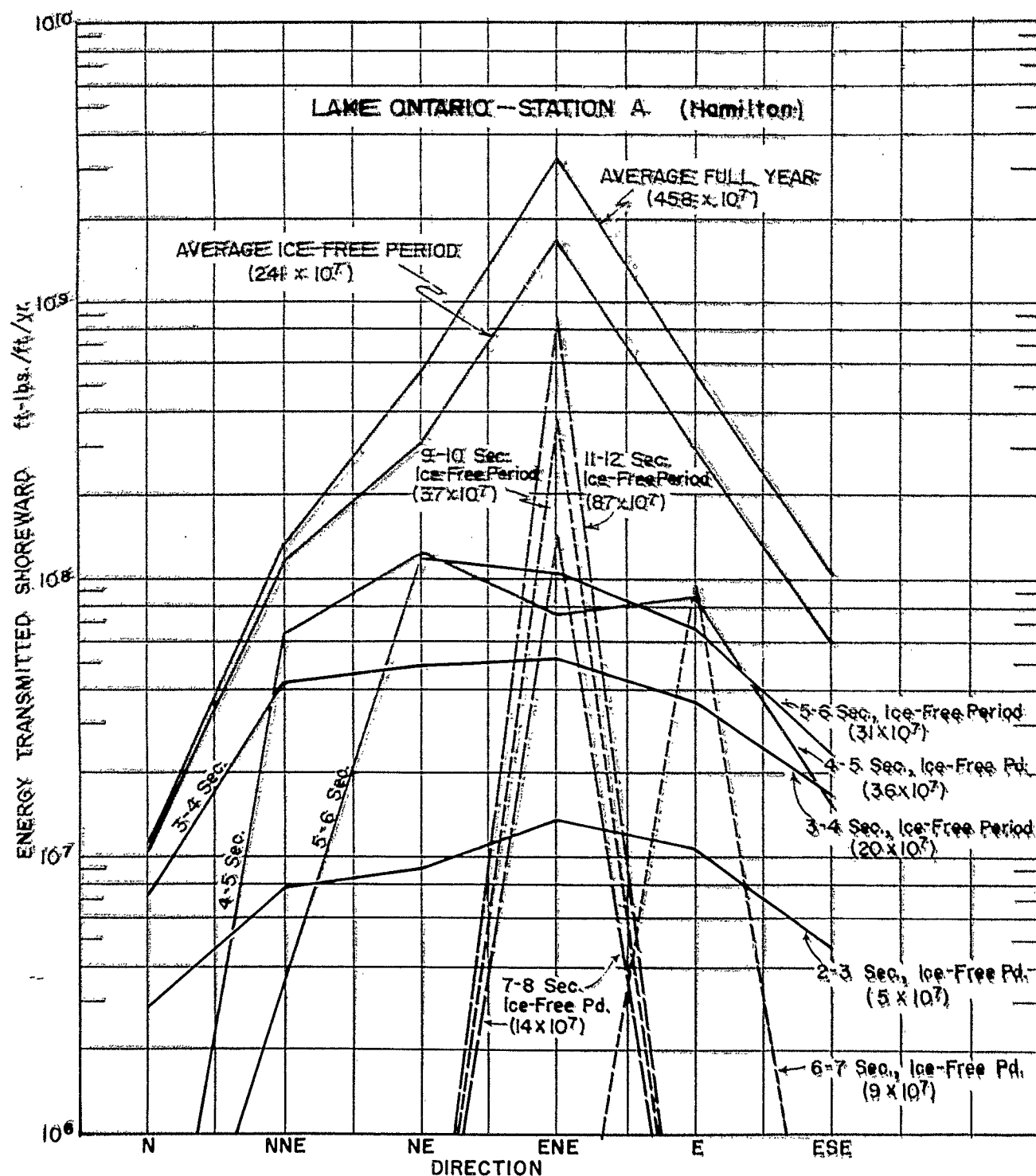


FIG. A-1





AVERAGE AMOUNT OF ENERGY TRANSMITTED SHOREWARD PER FOOT OF CREST LENGTH PER YEAR, IF WAVE SYSTEM IS CONSIDERED AS AN HYPOTHETICAL UNIFORM SYSTEM COMPOSED OF WAVES OF SIGNIFICANT HEIGHT AND PERIOD ONLY.

FIG. A-4

WAVE AND LAKE LEVEL STATISTICS

FOR

LAKE ONTARIO

APPENDIX B

WAVE STATISTICS

FOR

ROCHESTER, NEW YORK

Period	2-3 Seconds										3-4 Seconds										4-5 Seconds										5-6 Seconds										6-7 Seconds										7-8 Seconds										TOTAL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.

[illegible]

WAVE AND LAKE LEVEL STATISTICS

FOR

LAKE ONTARIO

APPENDIX B

WAVE STATISTICS

FOR

ROCHESTER, NEW YORK

TABLE B-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.

Duration given in hours. Height and period groupings include lower value but not the upper.

JANUARY

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				2-7 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
.5-1	W		12		12																	12		12	
	WNW			6	6																		6		6
	N	6	18		24																	6	18		24
	NNE	12			12																	12			12
	NE	12		12	24																	12		12	24
	E		12		12																		12		12
1-2	WNW	30	42	18	90																	30	42	18	90
	W					30			30													30			30
	WNW		6		6	12	24	12	48													12	30	12	54
	N		6		6	6	12	6	24													6	12	12	30
	NNE			6	6	6	18	6	30													6	24	6	36
	E			6	6	6	6	6	6													6	6	12	24
2-3	WNW					6			6													6			6
	W					12	6	6	18				6									12	6	6	24
	WNW						6	6	12				18									18	12	6	36
	N							6	6				18									6	18	6	24
	NNE					6		6	12				12									6	12	6	24
	E					6	6	6	18				24									18	12	6	36
3-4	WNW					30	12	18	60	24	48	72										54	60	18	132
	W									6	6	12				6						6	12		18
	WNW									12	6	18										12	6		18
	N									6		6	12									6	6	6	18
	NNE									6	6	12										6	6	6	18
	E									6	12	18										6	12	6	24
4-5	WNW									36	30	12	78									36	42	12	90
	W													6			6					6			6
	WNW									6	6	12		6	24	12	42					6	30	18	54
	N									6	6	12										6	6	6	18
	NNE									6		6										6	6	6	18
	E									6		6		6	6	12						6	6	6	18
5-6	WNW									12	12	6	30					12				12	12		24
	W													6			6					6			6
	WNW													6	6	6	6					6	6	6	18
	N													6			6					6	6	6	18
	NNE													6	6	6	6					6	6	6	18
	E													12	6	6	24	12				12	24	6	36
6-7	WNW													6			6					6			6
	W													6			6					6			6
	WNW													6			6					6			6
	N													6			6					6			6
	NNE													6			6					6			6
	E													6			6					6			6
8-10	WNW																	12				12			12
	W																								
	WNW																								
	N																								
	NNE																								
	E																								
TOTAL		36	60	30	126	90	84	66	240	72	90	18	180	36	54	18	108	12	12		24	246	300	132	678
CALM TOTAL HOURS																						498	444	612	1554
																						744	744	744	2232

TABLE B-1

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.

FEBRUARY

B-2:

TABLE B-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds				8-9 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-7	WIND			12	12																								
	SW		12		12																								
	SE	6		12	18																								
	NE		6	6	12																								
	NW		6		6																								
	TOTAL	12	30	30	72																								
1-2	WIND				6	36	24	66																					
	SW		6		6	18	18	36																					
	SE		6		6	12	6	18																					
	NE					18	6	24																					
	NW	6			6	18	6	24																					
	TOTAL	6	12		18	66	30	120																					
2-3	WIND				6	6	6	12																					
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
3-4	WIND					6	18	24																					
	SW					6	12	18																					
	SE																												
	NE																												
	NW																												
	TOTAL					6	18	24																					
4-5	WIND					6	12	12																					
	SW					6	12	12																					
	SE																												
	NE																												
	NW																												
	TOTAL					6	12	12																					
5-6	WIND																												
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
6-7	WIND																												
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
7-8	WIND																												
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
10-11	WIND																												
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
11-12	WIND																												
	SW																												
	SE																												
	NE																												
	NW																												
	TOTAL																												
TOTAL		18	42	30	90	70	90	66	234	96	90	36	222	24	42	54	120	30	48	78	6	6	12	222	310	204	726		
CALM HOURS																													
TOTAL HOURS																													

TABLE B-1
 STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
 Duration given in hours. Height and period groupings include lower value but not the upper.
 APRIL

APRIL

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds				2-8 Seconds				
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	
5-1	W	6			6																					6			6	
	WNW	12			12																					12			12	
	WN		24	18	42																					6	24	18	42	
	WNW			6	6																					6			6	
	N	6	24	6	36																					6	24	6	36	
	NNE		6		6																					6			6	
	NE			6	6																					6	24	6	36	
	NNE	6			6																					6			6	
	E	24			24																					6	6	6	12	
	TOT	54	54	54	162																					42	6	12	60	
1-2	W	6			6	6	6	6	18																	24	54	54	132	
	WNW					30	18	18	66																	12	6	6	24	
	WN					6	24	36	66																	36	18	18	72	
	WNW		6		6	6	12	18	36																	6	24	36	66	
	N							12	12																		6	18	24	48
	NNE		6		6			18	18																		12	6	18	36
	NE							12	12																		24	6	30	60
	NNE	6			6	36	6	12	54																		12	6	18	36
	E																													
	TOT	12	12		24	84	108	90	282																	42	6	12	60	
2-3	WNW							6	6																					
	WN							6	6																					
	WNW							6	6																					
	NNE							6	6																					
	NE							6	6																					
	NNE							6	6																					
	TOT							6	6																					
	WNW							12	30	18	60																			
	WN							12	12	6	30																			
	TOT							12	12	6	30																			
3-4	WNW							6	18	6	24																			
	WN							6	18	6	24																			
	WNW							6	18	6	24																			
	N							6	18	6	24																			
	NNE							6	18	6	24																			
	NNE							6	18	6	24																			
	TOT							6	18	6	24																			
	WNW							6	18	6	24																			
	WN							6	18	6	24																			
	TOT							6	18	6	24																			
4-5	W													6	6															
	WNW													12	12															
	WN													6	6															
	WNW													6	6															
	N													6	6															
	NNE													6	6															
	NNE													6	6															
	TOT													6	6															
	WNW													6	6															
	WN													6	6															
5-6	W													18	24															
	WNW													6	24															
	WN													6	6															
	WNW													12	12															
	N													6	6															
	NNE													6	6															
	NNE													6	6															
	TOT													6	6															
	WNW													6	6															
	WN													6	6															
6-7	W													12	12															
	WNW													6	6															
	WN													6	6															
	WNW													6	6															
	N													6	6															
	NNE													6	6															
	NNE													6	6															
	TOT													6	6															
	WNW													6	6															
	WN													6	6															
7-8	W													12	12															
	WNW										</																			

MAY

CALM	TOTAL HOURS
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56
57	57
58	58
59	59
60	60
61	61
62	62
63	63
64	64
65	65
66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

TABLE B-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper
JUNE

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				2-7 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	WNW			6	6																	6		6	6
	NW	6		12	18																	6		12	18
	NNW	24		6	30																	24		6	30
	N	6	6		12																	6	6		12
	NNE		6		6																		6		6
	ENE		6		6																		6		6
1-2	TOTAL	36	18	24	78																	36	18	24	78
	WNW	12		6	18	12	18	24	54													24	18	30	72
	NW		6	6	12	12	6	6	24													12	12	12	36
	NNW																								
	N		6	6	12	18	6	6	30													18	12	12	42
	NNE					6			6														6		6
2-3	ENE		6		6																		6		6
	TOTAL	12	18	18	48	30	24	30	84													40	30	40	110
	W									6			6										6		6
	WNW									6			6										6		6
	NW						6		6				6										6		6
	N																								
3-4	NNE					6			6																
	ENE					6			6																
	TOTAL					12	6		18				12									12	18		30
	WNW									12	12	18	42									12	12	18	42
	NW									12	6	6	24									12	6	6	24
	NNW																								
4-5	TOTAL									24	18	30	72									24	18	30	72
	WNW													6	6	12	24					6	6	12	24
	NW													6	6	12	24					6	6	12	24
	NNW																								
	N																								
	NNE																								
5-6	TOTAL									12	6	18	36	6	6	12	24					12	6	18	36
	WNW																								
	NW																								
	NNW																								
	N																								
	NNE																								
6-7	TOTAL																								
	W																								
	WNW																								
	NW																								
	NNW																								
	N																								
TOTAL	TOTAL	48	36	42	126	66	36	72	174	42	30	36	108	6	6	18	30					6	6	18	30
	CALM																								
	TOTAL HOURS																								

JULY

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				2-6 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	WNW	6		6	12													6		6	12
	NW			6	6															6	6
	NNW		12		12													12			12
	N			6	6														6		6
	NNE	6			6													6			6
	ENE	6	6		12													6	6		12
1-2	TOTAL	18	18	12	48													18	18	12	48
	W	12			12	12	12	36	60									12	12		24
	WNW		6	6	12	12	6	18	36									12	12	12	36
	NW		6	6	12													12	30	6	48
	NNW																		30	6	36
	N		18	6	24	6			30									6	18	6	30
2-3	NNE		6	6	12														6	6	12
	ENE	6	6		12	6	6	6	18									12	12	6	30
	TOTAL	12	12	12	36	18	12	12	42									12	12	12	36
	W									6	12		18					6	12		18
	WNW																	6	6		12
	NW						6		6										6		6
3-4	N									12	6		18					12	6		18
	NNE																				
	ENE																				
	TOTAL									12	6		18					12	6		18
	W																				
	WNW																				
4-5	NW																				
	NNW																				
	N																				
	NNE																				
	ENE																				
	TOTAL																				
TOTAL	TOTAL	42	78	42	162	54	78	48	180	60	36	24	120	24				60	552	624	740
	CALM																				
	TOTAL HOURS																				

TABLE B-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.
AUGUST

HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				2-6 Seconds			
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	W	6			6													6			6
	NW			6	6															6	6
	N			6	6															6	6
	NE	12	12		24													12	12		24
	E			12	12															12	12
	SE			6	6															6	6
1-2	W			6	6															6	6
	NW			6	6	18	12	12	42									24	12	12	48
	N	6	6		12	24	12	12	48									18	30	12	60
	NE		6		6	24	18	18	60									24	24	18	66
	E	6	6		12	24	12	12	48									6	24	12	42
	SE	6	6		12	12	36	18	66									18	12	18	48
2-3	W			6	6															6	6
	NW					12		12	12									12		12	12
	N					12	24	36	72									12	30	42	84
	NE					12	6	18	36									12	6	18	36
	E						6	6	12										6	6	12
	SE						6	6	12										6	6	12
3-4	W																				
	NW																				
	N									6	6	6	18					6	6	6	18
	NE																				
	E									12	6	12	30					12	6	12	30
	SE									12	6	12	30					12	6	12	30
4-5	W																				
	NW																				
	N																				
	NE																				
	E																				
	SE																				
TOTAL		42	30	48	120	144	106	70	320	42	24	36	102	12			12	240	240	174	654
CALM																		549	549	570	1668
TOTAL HOURS																		799	799	799	2397

SEPTEMBER

SEA FEMUR																						
HEIGHT (FEET)	Period	2 - 3 Seconds				3 - 4 Seconds				4 - 5 Seconds				5 - 6 Seconds				2 - 6 Seconds				
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	
5-1	WNW			6	6																	
	WN			6	6																	
	N			12	12																	
	NNE			18	18																	
	NE			12	12																	
	ENE				6																	
	TOTAL	48	12	48	108													48	12	48	108	
3-2	WNW							12	6	18												
	WN		6	6	12	6	24	12	42										12	6	18	
	WNW							6	18										30	18	54	
	N				6	6	36	24	24	84									12	6	18	
	NNE		12		6	18	18			18									36	24	30	
	NE		6		6	12	18			30	24								30	6	36	
	ENE								24	24								24	36	60		
	TOTAL	18	6	24	48	78	78	180	252									76	78	186	360	
2-3	N							6											6			
	WNW							12	12										12			
	N							18	18										18			
								6	30										6	30		
3-4	WNW									6	12	18							6	12	18	
	WN						6		6										6	6		
	N										6	6								6		
	NNE											6	6							6		
	ENE											18	24						18	24		
	TOTAL						6	6	6	6	30	60							6	12	30	66
4-5	WNW																					
	WN																					
	N																					
	NNE																					
	ENE																					
	TOTAL																					
5-6	WNW																					
	WN																					
	N																					
	NNE																					
	ENE																					
	TOTAL																					
TOTAL		66	18	72	156	84	108	102	292	6	6	34	46					24	24	156	252	570
CALM																						
TOTAL HOURS																						

OCTOBER 1964

NOVEMBER

B-8

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.

DECEMBER

HEIGHT (FEET)	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				8-7 Seconds																				
	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total																					
5-1	WHW	6			6													6			6																				
	NW		6																6		6																				
	WHW			6	12															6	12																				
	N			18	18															18	18																				
	NWE	6																6			6																				
	NE	6	6		12													6	6		12																				
	ENE			6	6															6	6																				
TOTAL	18	18	30	66													18	18	30	66																					
1-2	WHW				18	6	12	36										18	6	12	36																				
	NW					6	12	36										18	6	12	36																				
	WHW	12			12													12																							
	N				6	18	6	30										6	18	6	30																				
	NWE						6	6												6	6																				
	NE						6	6												6	6																				
	ENE						6	6												6	6																				
TOTAL	12			12	54	30	54	138									66	30	54	150																					
2-3	WHW							6										6			6																				
	TOTAL							6										6			6																				
3-4	WHW							6	12	12	30		6			6			12	12	12	36																			
	NW								12		12							12			12																				
	WHW								18	18										18	18																				
	N							6	6		12							6	6		12																				
	NWE							6			6							6		6	6																				
	E							6			6							6		6	6																				
	TOTAL							36	18	30	84		6			6		42	18	30	90																				
4-5	WHW												6	6	12				6	6	12																				
	NW												12		12				12		12																				
	TOTAL												18	6	24				18	6	24																				
5-6	WHW												6	6	12				6	6	12																				
	NW												6		6				6		6																				
	TOTAL												12	6	18				12	6	18																				
6-7	WHW																	6	6		6																				
	TOTAL																	6	6		6																				
7-8	WHW																	6	6		6																				
	NW												6		6				6		6																				
	TOTAL												6		6			6	6		6																				
TOTAL	30	18	30	78	60	36	60	156	36	18	30	84	24	24	12	60		12	12	150	96	144	390																		
CALM:																		576						648						600						1080					
TOTAL HOURS:																		744						744						744						2232					

FULL YEAR

FULL YEAR

[illegible]

TABLE B-3
 STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
 ICE-FREE PERIOD (1 APRIL-30 NOV.)
 Duration given in hours. Height and period groupings include lower value but not the upper.

Section given in header height and period groupings include lower value but not the upper.																														
HEIGHT (FEET)	Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds				8-9 Seconds				
		1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	
5-1	W	12			12																					12			12	
	WNW	36	6	36	78																					36	6	36	78	
	W	24	52	60	126																					24	52	60	126	
	WNW	54	36	24	114																					54	36	24	114	
	N	84	48	54	186																					84	48	54	186	
	ENE	60	18	48	126																					60	18	48	126	
	ENE	18	12	48	78																					18	12	48	78	
1-2	ENE	22	30	36	108																					22	30	36	108	
	E	24			24																					24			24	
	TOTAL	354	122	256	732																					354	122	256	732	
	W	18			18	6	18	6	30																		18	6	18	30
	WNW	24	12	24	60	70	138	182	390																	24	18	6	48	
	W	12	36	24	72	70	70	84	252																	120	150	126	496	
	WNW	6	12	6	24	24	132	42	198																	90	126	108	324	
2-3	N	6	36	30	72	120	78	78	276	6			6													30	144	48	222	
	ENE	18	18	18	54	92	54	54	150	12			12													132	114	108	354	
	N	30	12	6	48	84	72	84	240																	72	72	72	216	
	ENE	18	18		36	66	30	60	156	6			6													114	84	70	268	
	E					24		6	30																	90	78	60	178	
	TOTAL	182	188	180	550	534	612	516	1662	24			24													24	6	6	30	
	W					12	6	18	36				6													696	756	624	2076	
3-4	WNW					12	12	12	36	30	36		6													12	12		24	
	W					30	18	6	54	24	12		36													42	48	12	102	
	WNW					6	54	40	110	12	24		36													54	30	6	90	
	N					24	54	6	84	12	36		48													18	78		96	
	ENE					24	12		36				6													36	90	6	132	
	N					6	6	6	18	12	6		18													30	12		42	
	TOTAL					120	174	30	324	96	120		216													6	12		180	
4-5	W					12	6		18																	12	6		18	
	WNW					24	66	96	186	6			6													30	66		192	
	W					6	6	6	12	42	30		30													42	36	36	114	
	WNW					6	6	6	12	6	6		42													12	6	30	48	
	N					18	48	18	84				84													24	48	18	90	
	ENE					36	12	36	84				84													36	12	36	84	
	TOTAL					60	162	162	384	18	42		120													60	120	72	252	
5-6	W					6	6	6	12																	12	6		18	
	WNW					24	66	96	186	6			6													30	66		192	
	W					6	6	6	12	42	30		30													42	36	36	114	
	WNW					6	6	6	12	6	6		42													12	6	30	48	
	N					18	48	18	84				84													24	48	18	90	
	ENE					36	12	36	84				84													36	12	36	84	
	TOTAL					60	162	162	384	18	42		120													60	120	72	252	
6-7	W					6	6	6	12																	12	6		18	
	WNW					24	66	96	186	6			6													30	66		192	
	W					6	6	6	12	42	30		30													42	36	36	114	
	WNW					6	6	6	12	6	6		42																	

TABLE B-4

STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.

ICE-FREE PERIOD (1 APRIL - 30 NOV.)

Energy given in foot-pounds per foot of crest per year $\times 10^6$; Height and period groupings include lower value but not the upper

Height (ft.)	Period						
	Dir.	2-3 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds
5-1	W	40					40
	WNW	262					262
	WN	423					423
	NNW	383					383
	N	625					625
	NNE	423					423
	NE	262					262
	ENE	363					363
1-2	E	81					81
	Total	2862					2862
	W	240	565				805
	WNW	801	6215			210	7225
	WN	961	4745				5706
	NNW	320	3728				4048
	N	961	5197	146			6304
	NNE	721	2825	291			3837
2-3	NE	691	4519				5160
	ENE	481	2937	146			3564
	E		565				565
	Total	5126	31295	583		210	37214
	W	937		404			1341
	WNW		1874	4439			6313
	WN		2811	2421			5232
	NNW		3123	2421			5544
3-4	N		4372	3228			7600
	NNE		1874	404			2278
	NE		937	1211			2148
	ENE		937				937
	Total		16865	14528			31393
	W			2366			2366
	WNW			24453	967		25420
	WN		1215	13410			14625
	NNW		608	5521			6129
4-5	N		608	11043			11651
	NNE			11043			11043
	NE			4733	1934		6667
	ENE			8677	967		9644
	E		608	1578			2186
	Total		3039	82824	3868		89731
	W			2578	4723		7301
	WNW			1299	23963		25262
5-6	WN			5196	15976		21172
	NNW			3897			3897
	N			5176	3175		8351
	NNE			1299	1598		2897
	NE			1299	7988		9287
	ENE			1299			1299
	Total			22083	57513		79596
	WNW				21414		21414
6-7	WN				7138		7138
	NNW				2379		2379
	NNE				4759	2820	7579
	NE				2379		2379
	ENE				4759		4759
	Total				42828	2820	45648
	W				19672		19672
	WNW				11803		11803
7-8	WN				15738		15738
	NNW				3315		3315
	Total				4315	47213	50528
	WNW				14460		14460
	N				5230		5230
	Total				15690		15690
	ENE				6787		6787
	WNW					9694	9694
9-10	ENE				16723		16723
	Total				16723	9694	26417
	WNW					14172	14172
	ENE					14172	14172
	Total					28344	28344
	11-12						
	Total						
	TOTAL	7288	51199	120018	107524	89363	38038
							414130

TABLE B-5
STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION B, ROCHESTER, N.Y.
FULL YEAR

Energy given in foot-pounds per foot of crest per year $\times 10^4$. Height and period groupings include lower value but not the upper

Height (feet)	Period Dir.	2-3 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds	2-8 Seconds
5-1	W	40						40
	WNW	403						403
	NW	585						585
	NNW	444						444
	N	847						847
	NNE	645						645
	NE	764						764
	ENE	444						444
	E	81						81
	Total	3953						3953
1-2	W	240	678					918
	WNW	801	9490			210		19501
	NW	1202	2457					8659
	NNW	721	5710					6031
	N	1041	6892	146				8079
	NNE	881	3954	291				5126
	NE	961	6101					7062
	ENE	641	4180	146				4967
	E	80	771			210		871
	Total	6568	44853	589				52214
2-3	W		1562	404				1966
	WNW		4040	6456				10516
	NW		4040	3632				7692
	NNW		3435	3632				7067
	N		4927	3632				8629
	NNE		2498	1614				4112
	NE		1874	2025				3699
	ENE		1247	807				2056
	E							
	Total		23795	23002				46737
3-4	W			5522				5522
	WNW			35497	2901			38398
	NW		1823	22876				24699
	NNW		608	11832				12440
	N		608	18143				18751
	NNE			16565				16565
	NE			7888	2301			19789
	ENE			2446	1934			11400
	E		608	3844				4552
	Total		3647	131733	7736			143116
4-5	W			2578	6390			8968
	WNW			7795	48524			53319
	NW			10393	27159			32552
	NNW			7795				7795
	N			4496	3195			8691
	NNE			1299	1598			2897
	NE			2578	1183			13781
	ENE			2578	6793			7391
	E				1598			1598
	Total			41572	105440			147012
5-6	W			1932	2379			4311
	WNW			1932	30931			32863
	NW				23793			23793
	NNW			1932	7138			9070
	N							
	NNE				4759	2820		7579
	NE				4759			4759
	ENE				7138			7138
	E							
	Total			5796	80897	2820		89513
6-7	W					18672		18672
	WNW				13259	36476		44735
	NW					23606		23606
	NNW							
	N				3315			3315
	NNE				3315			3315
	NE							
	ENE					18672		18672
	E					94426		114315
	Total				19889	36612		36612
7-8	W					5230		5230
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					4401		4401
8-9	W					47072		47072
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					13413		13413
9-10	W					6707		6707
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					20120		20120
10-11	W					8361	19388	27749
	WNW					8361		8361
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					16723		16723
11-12	W					33445		33445
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					23656		23656
12-13	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					14172		14172
TOTAL	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					42516		42516
TOTAL	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					16042		16042
TOTAL	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					19809		19809
TOTAL	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					113400		113400
TOTAL	W							
	WNW							
	NW							
	NNW							
	N							
	NNE							
	NE							
	ENE							
	E							
	Total					815328		815328

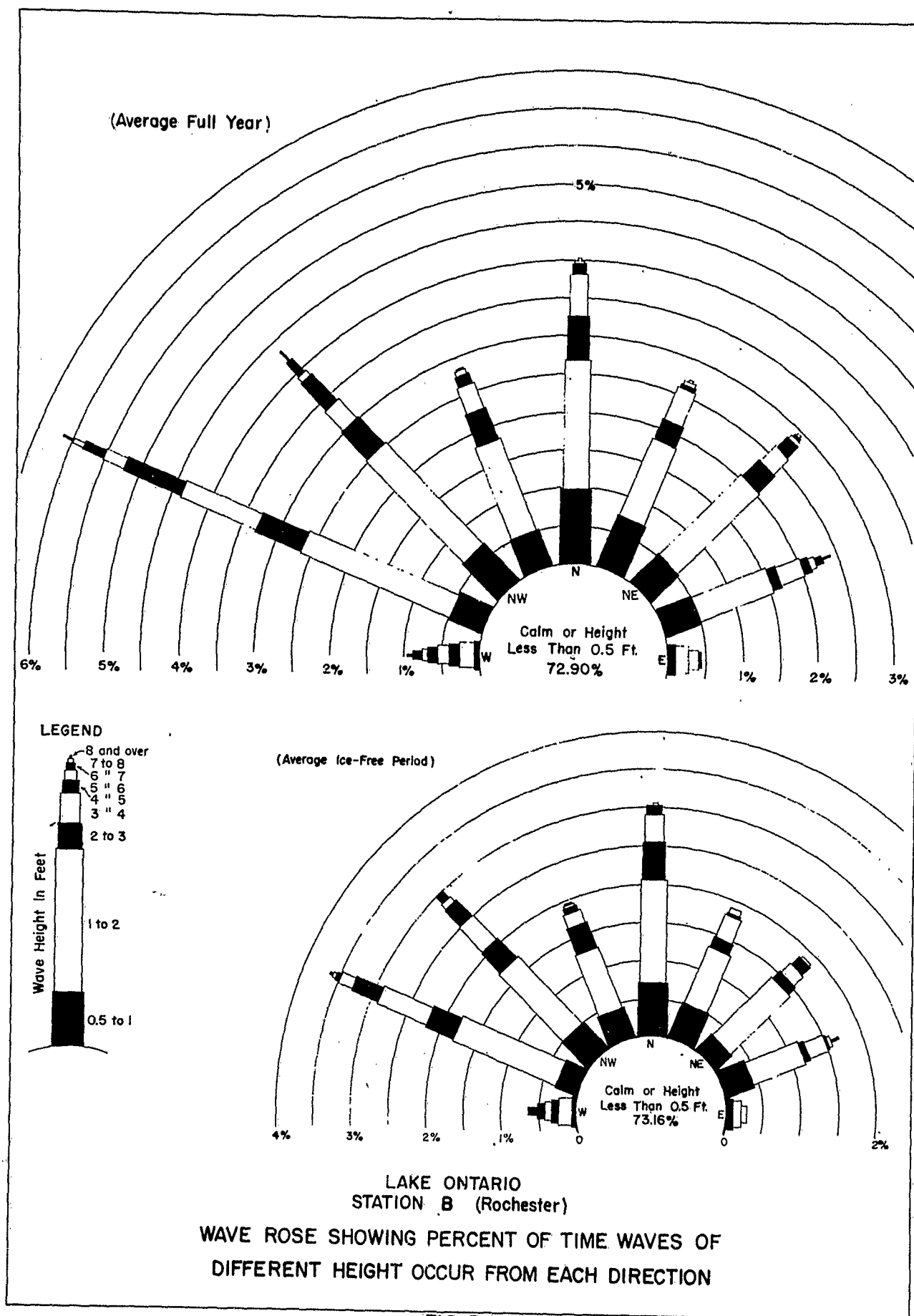
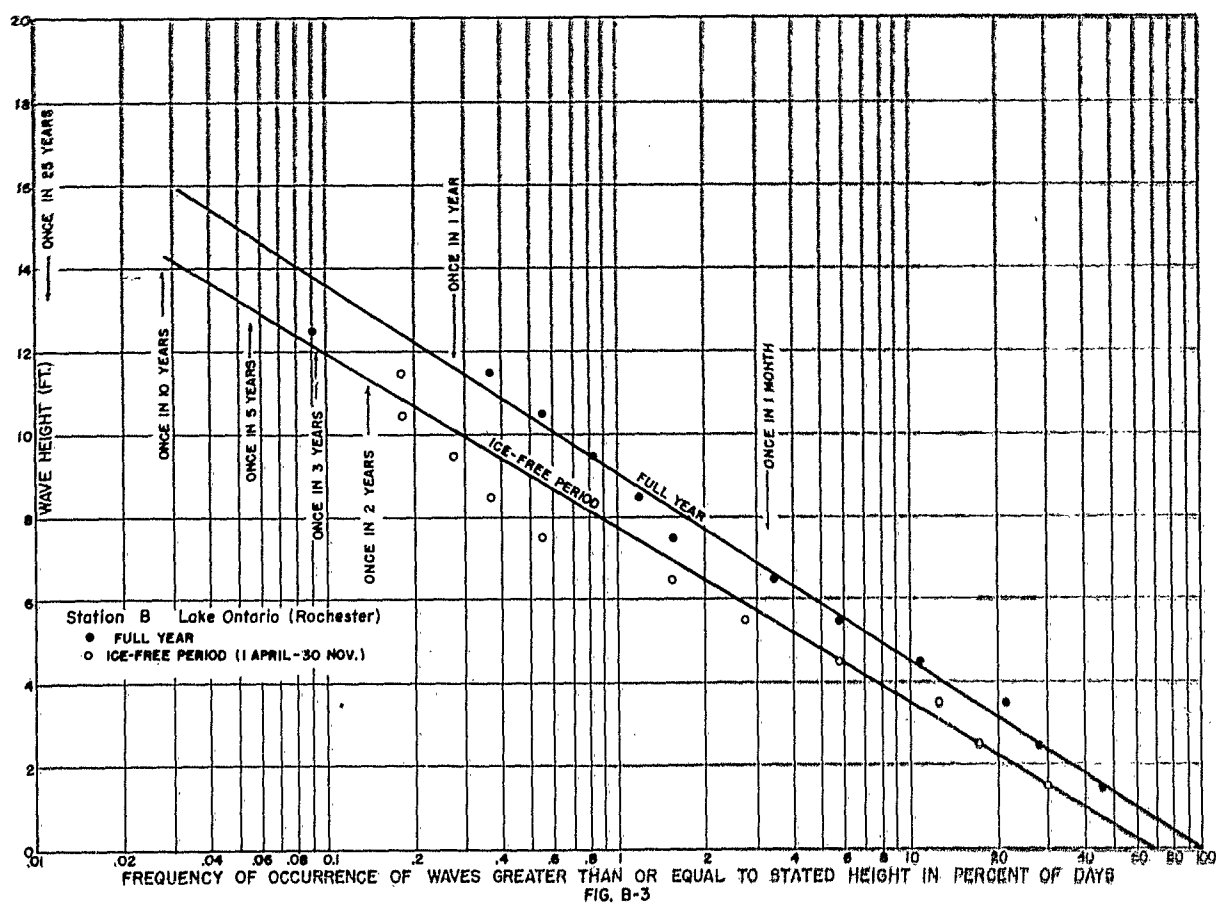
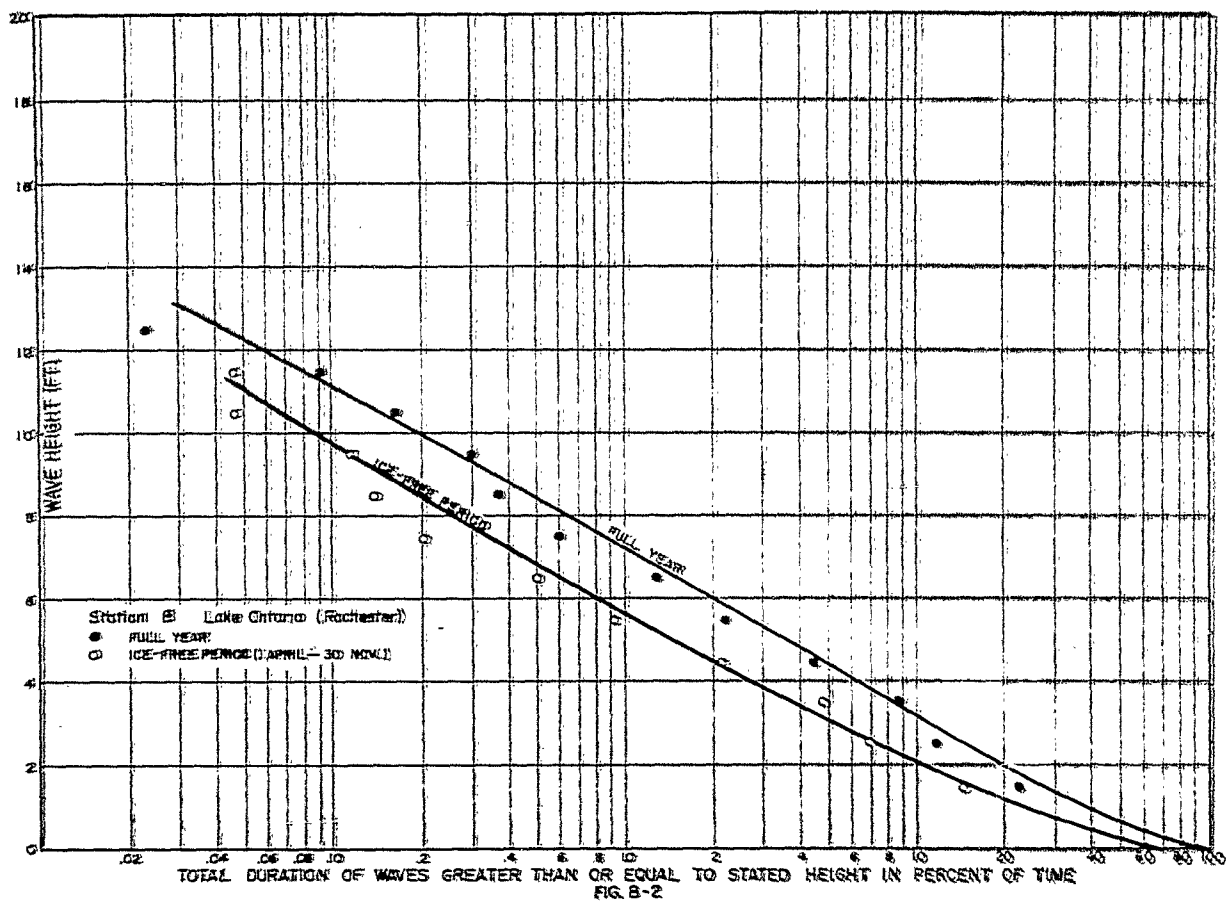
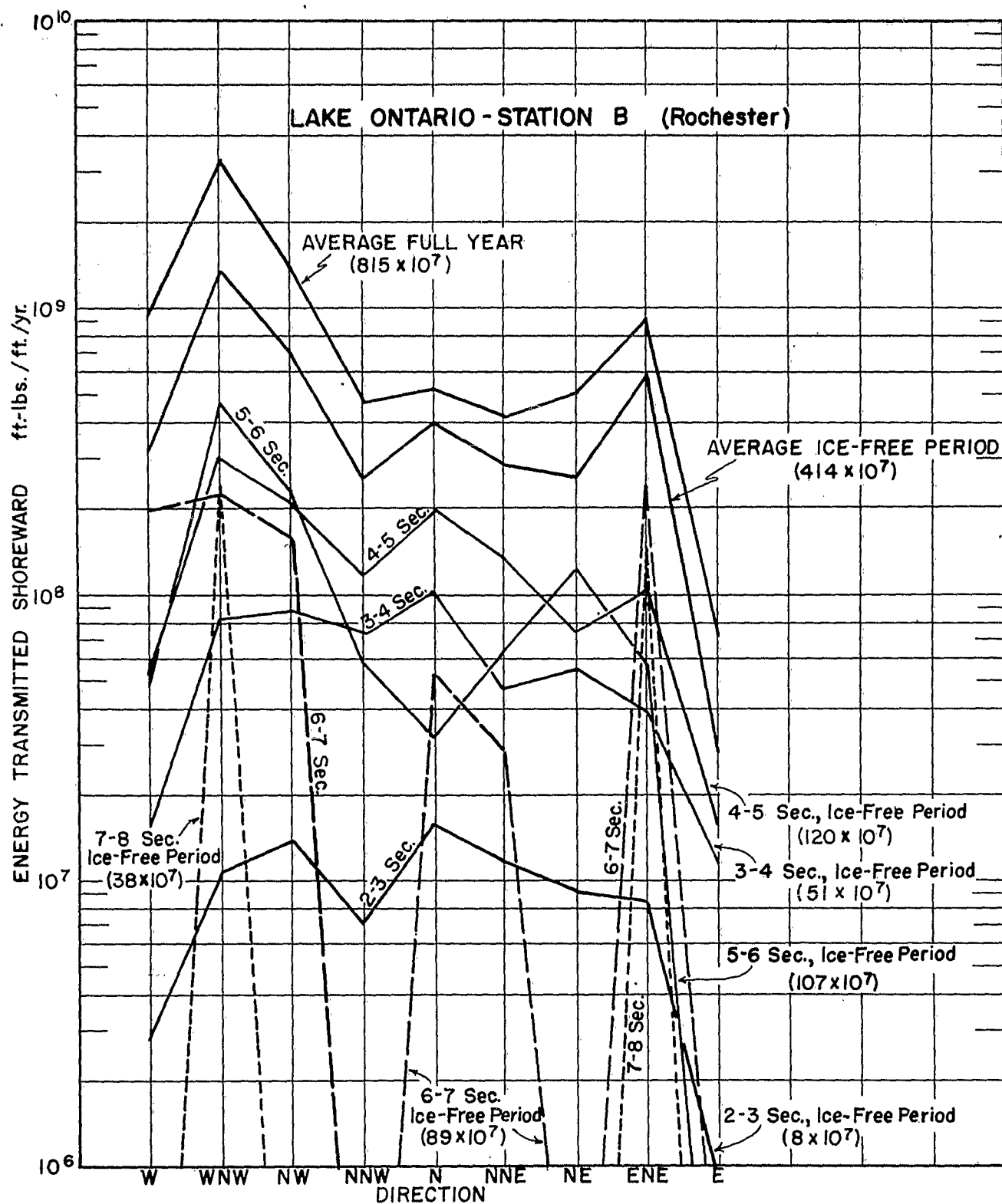


FIG. B-1





AVERAGE AMOUNT OF ENERGY TRANSMITTED SHOREWARD PER FOOT OF CREST LENGTH PER YEAR, IF WAVE SYSTEM IS CONSIDERED AS AN HYPOTHETICAL UNIFORM SYSTEM COMPOSED OF WAVES OF SIGNIFICANT HEIGHT AND PERIOD ONLY

FIG. B-4

WAVE AND LAKE LEVEL STATISTICS

FOR

LAKE ONTARIO

APPENDIX C

WAVE STATISTICS

FOR

STONY POINT, NEW YORK

TABLE C-1

C+1

MARCH

C-3

TABLE C-1

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION Q, STONY POINT, N.Y.

Duration given in hours. Height and period accelerations include lower value but not the upper.

'LINE'

JULY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

AUGUST

SEPTEMBER

1

TABLE C-1

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION O, STONY POINT, N.Y.
Duration given in hours. Height and period averages include lower value but not the upper.

OCTOBER

C-7

TABLE C-1.

STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION C, STONY POINT, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.

NOVEMBER •

C-8

TABLE C-1
STATISTICAL HINDCAST DATA FOR LAKE ONTARIO STATION C, STONY POINT, N.Y.
Duration given in hours. Height and period groupings include lower value but not the upper.
DECEMBER

Period	2-3 Seconds				3-4 Seconds				4-5 Seconds				5-6 Seconds				6-7 Seconds				7-8 Seconds				8-9 Seconds			
	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total	1948	1949	1950	Total
5-1	SSW	6	6	12	24																				6	6	12	24
	SW	6	6		12																				6	6		12
	WSW	18	18	6	42																				18	18	6	42
	W	6	6		12																				6	6		12
	WNW	12		12	30																				12		12	30
	WNC	6			6																				6			6
TOTAL	60	36	30	126																					60	36	30	126
1-2	SSW					18	6		24																18	6		24
	SW					18	66	12	96																24	66	12	102
	WSW					30	24	42	96	12	12		24												48	42	60	150
	W					18	36		54	6	36	12	54												24	36	30	90
	WNW					24	24	12	60																24	24	12	60
	WNC					18	6	12	36																18	6	12	36
TOTAL	12	6	18	36	126	126	78	342	18	48	12	78													156	180	126	462
3	SSW																											
	SW																											
	WSW																											
	W																											
3-4	SSW																											
	SW																											
	WSW																											
	W																											
4-5	SSW																											
	SW																											
	WSW																											
	W																											
5-6	SSW																											
	SW																											
	WSW																											
	W																											
6-7	SSW																											
	SW																											
	WSW																											
	W																											
7-8	SSW																											
	SW																											
	WSW																											
	W																											
8-9	SSW																											
	SW																											
	WSW																											
	W																											
9-10	SSW																											
	SW																											
	WSW																											
	W																											
11-12	SSW																											
	SW																											
	WSW																											
	W																											
TOTAL	72	42	48	162	150	150	96	396	60	102	114	276	42	66	78	186	36	54	36	126	12	6	18	360	426	378	1164	
CALM																												
TOTAL HOURS																												

Duration given in hours. Height and period groupings include lower value but not the upper.

Duration given in hours. Height and period groupings include lower value but not the upper.

Duration given in hours. Height and period groupings include lower value but not the upper.

CALM
TOTAL HOURS

TABLE C-4
STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION C, STONY POINT, N.Y.

ICE-FREE PERIOD (1 APRIL-30 NOV.)

Energy given in foot-pounds per foot of crest per year $\times 10^4$; Height and period groupings include lower value but not the upper

Height (Feet)	Period (Secs)	2-2 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds	8-9 Seconds	9-10 Seconds	10-12 Seconds
5-1	SEW	1000								500
	SW	1000								1000
	NEW	1000	200							1000
	W	1000								1000
	NEW	1000								1000
1-2	SEW	2000	200							2000
	SW	2000	2000							2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
2-3	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
3-4	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
4-5	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
5-6	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
6-7	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
7-8	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
8-9	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
9-10	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
10-11	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
11-12	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
12-13	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
13-14	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
14-15	SEW	2000	1000	1000	1000					2000
	SW	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
	W	2000	1000	1000	1000					2000
	NEW	2000	1000	1000	1000					2000
TOTAL		10,676	72,002	100,150	200,776	205,257	166,652	157,122	76,866	1,079,622

TABLE C-5
STATISTICAL ENERGY DATA FOR LAKE ONTARIO STATION C, STONY POINT, N.Y.
FULL YEAR

Energy given: in foot-pounds per foot of crest per year $\times 10^{-6}$. Height and period groupings include lower value but not the upper

Height (feet)	Period (Secs)	2-3 Seconds	3-4 Seconds	4-5 Seconds	5-6 Seconds	6-7 Seconds	7-8 Seconds	8-9 Seconds	9-10 Seconds	10-12 Seconds
5-1	SSW	706								706
	SW	1280								1280
	WSW	2831	28							1859
	W	887		45						892
	WSW	565								565
1-2	SW	363								363
	WSW	20								20
	SW	5161	28	45						5234
	SW	961	4506							5367
	SW	2483	15252	146						17801
2-3	WSW	1602	18320	2348	178					24448
	W	1121	2038	5677						15836
	WSW	1202	9264							10866
	SW	1091	4519							5560
	WSW	240	452							492
3-4	SW	8570	62251	2171	178					80170
	SW		987							937
	SW		6266	3228						9474
	WSW		7888	16544	494					24846
	W		6266	6860	1892					18588
4-5	WSW		6871	1211						8082
	SW		5809	1614						6223
	WSW		937	444						1341
	SW		35854	23861	1876					46121
	SW		608	13410						16018
5-6	SW		608	26031	1934					28573
	WSW		2430	48118	1333	1144				71835
	W		2430	41019	7377		1322			52594
	WSW			51273						51273
	SW		1823	35487						37320
6-7	WSW			1578						1578
	SW		7899	216226	29014	1144	1322			254305
	SW			2590						2590
	SW			7795	12780	1892				22867
	WSW			12391	187037	5676	2184			127888
7-8	W			6286	70293	20812				37601
	WSW			9094	3195					12282
	SW			3897	1598					5635
	WSW			42871	196383	28380	2184			268338
	SW				19276					16276
8-9	SW				26172					26172
	WSW				48241	31074				35265
	W				57183	37885				96588
	WSW				48207					45282
	SW				86176					24674
9-10	WSW				233171	70509				308680
	SW				3915					3915
	SW				16574	21447				40181
	WSW				18257	66885				80144
	W				5794	31074	9114			50324
10-11	WSW				11257	3734				17192
	SW				66367	115862	9114			191367
	SW					5230				5230
	WSW				4901	48819	6054	7686		53784
	W					26152	34824			62476
11-12	WSW				17603	5230				22833
	SW				4901					4901
	WSW				26505	78655	42378	7686		156924
	SW					20120				20120
	WSW				5634	57652	23310			82576
12-13	W					32532	31080			62402
	WSW				5634	18413				19057
	SW				5634					5634
	WSW				16302	120718	56370			172010
	SW						8674			8674
13-14	WSW					25084	87248			112322
	W				7011	41807	58165			106383
	WSW					4261				4261
	SW					8361				8361
	WSW				7811	83613	155107			245731
14-15	SW						23656			23656
	W						35483	24882		62365
	WSW							18481		18481
	SW						57139	40323		97462
	WSW							16110		16110
15-16	W							16110		16110
	WSW							14172		14172
	SW							16110		16110
	WSW							14172		14172
	SW							48370		48370
16-17	WSW							57160		57160
	W							95100		95100
	WSW							152160		152160
	SW							66277		66277
	WSW							66277		66277
17-18	SW							132258		132258
	WSW							25590		25590
	W							25590	28620	51140
	WSW							30880	28620	79708
	W								32684	32684
TOTAL								33002		33002
		13731	109532	274874	265711	508721	337806	452853	60970	2356418

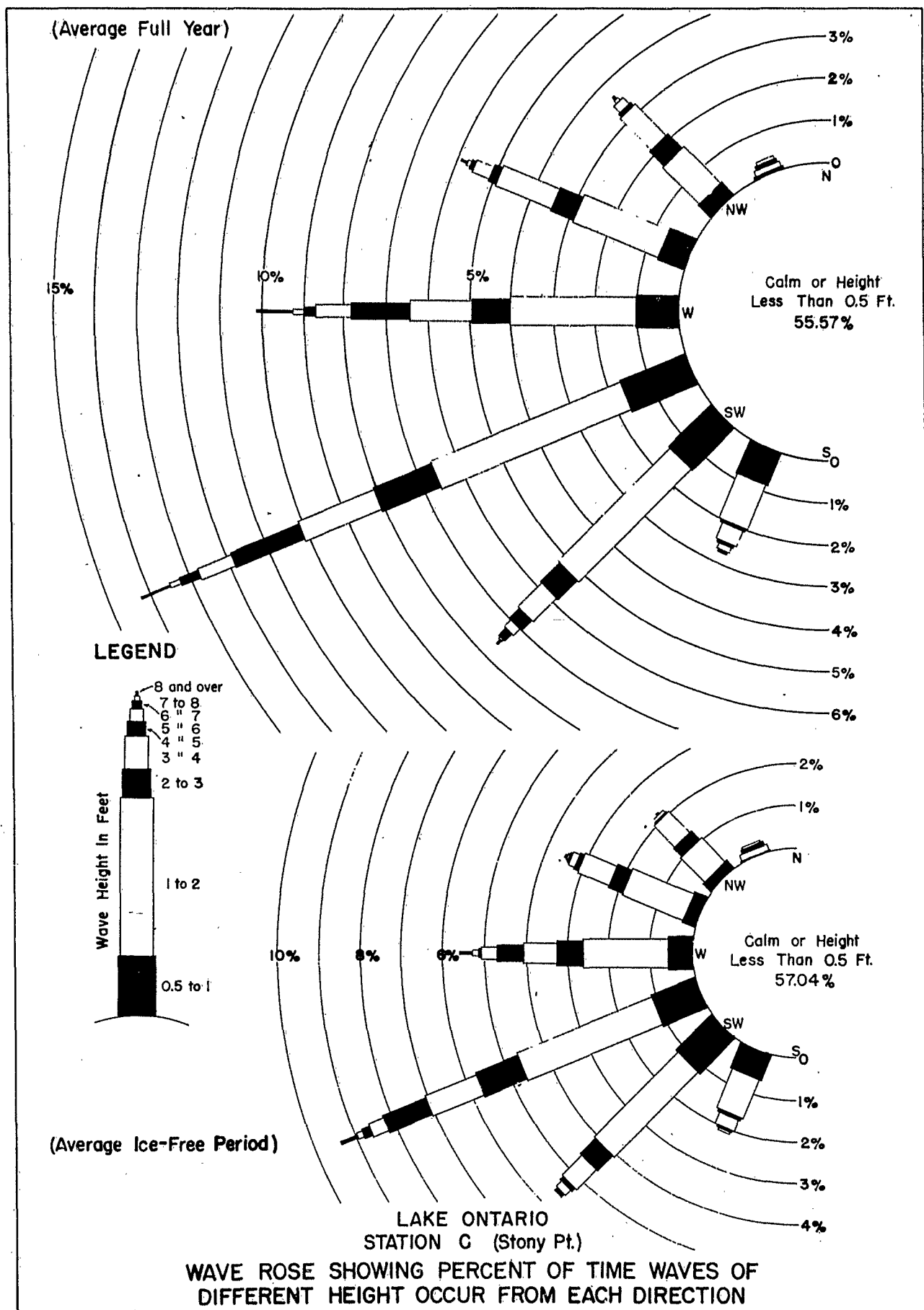
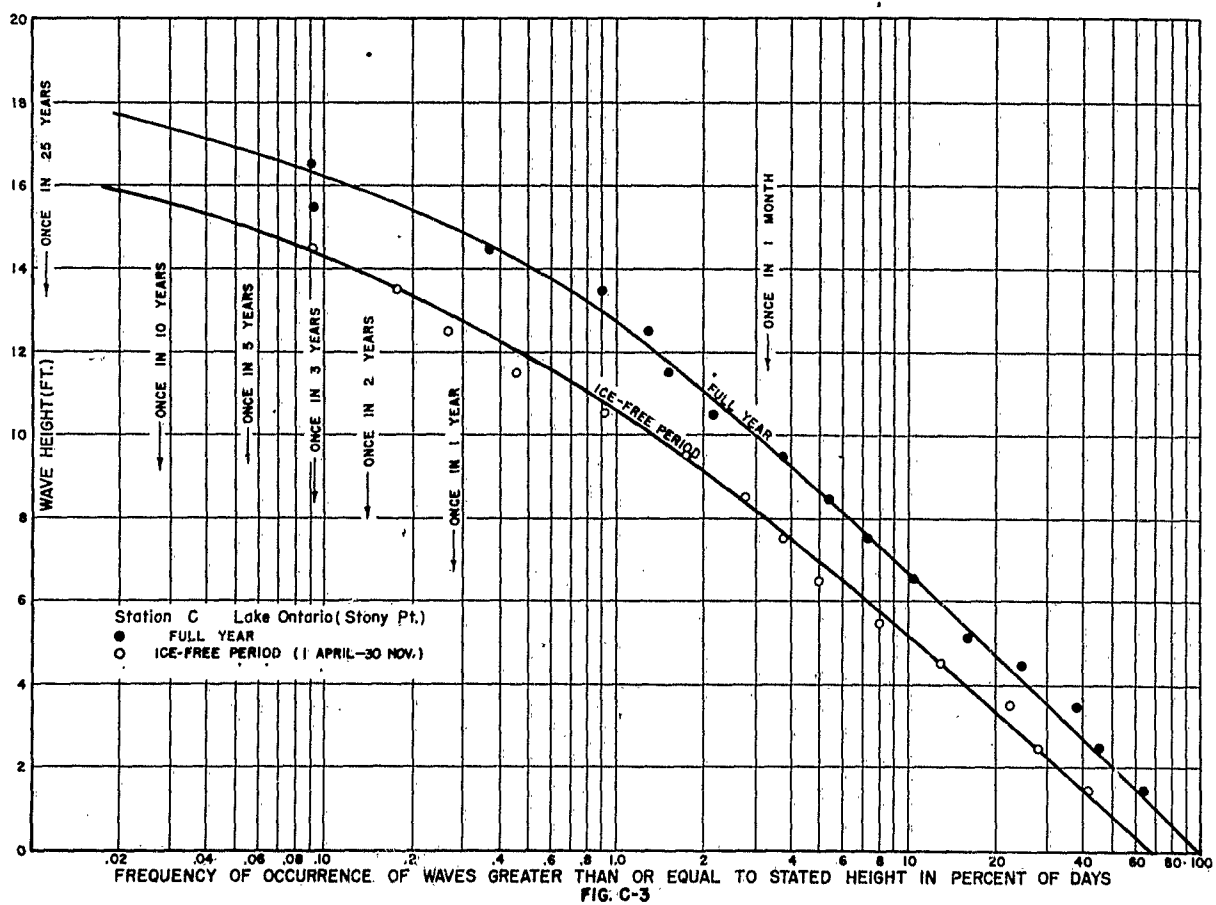
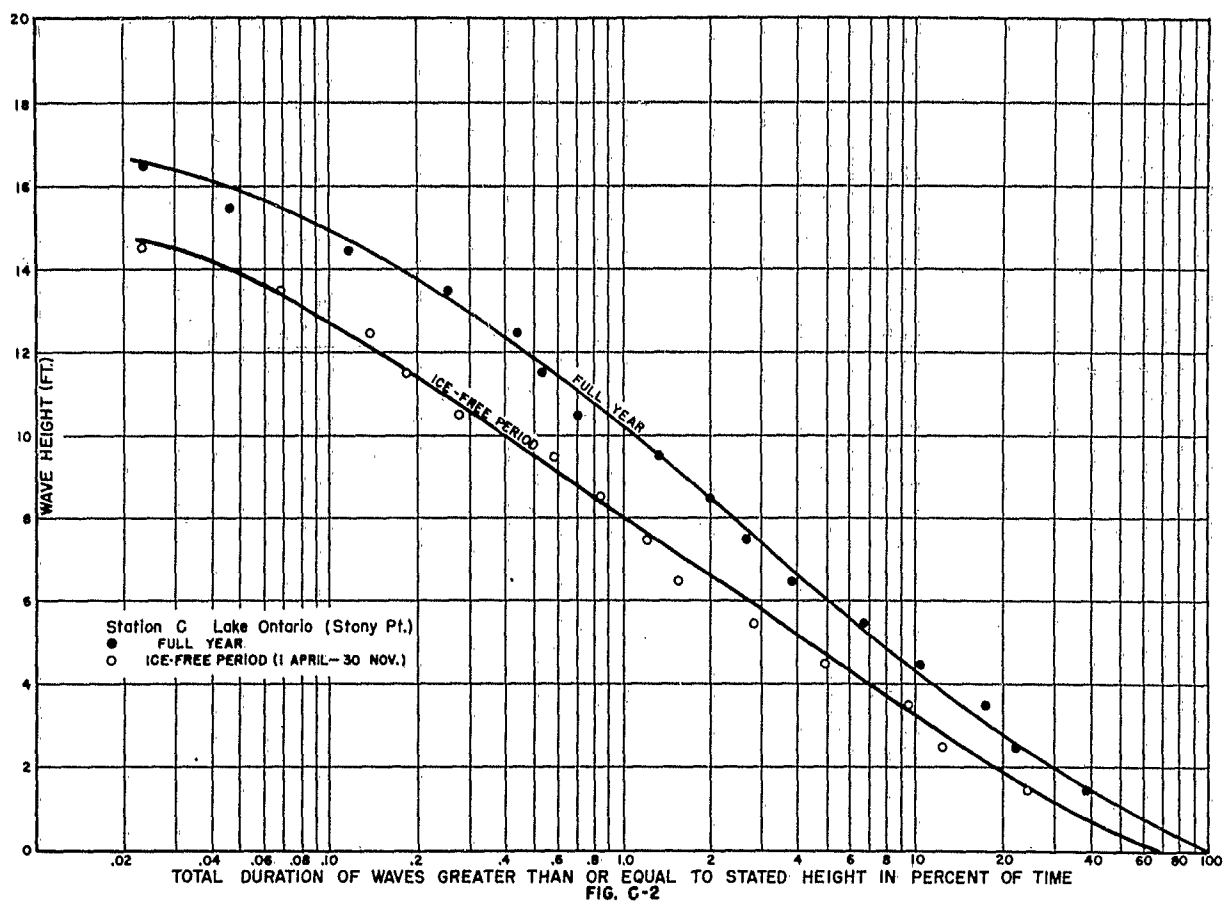
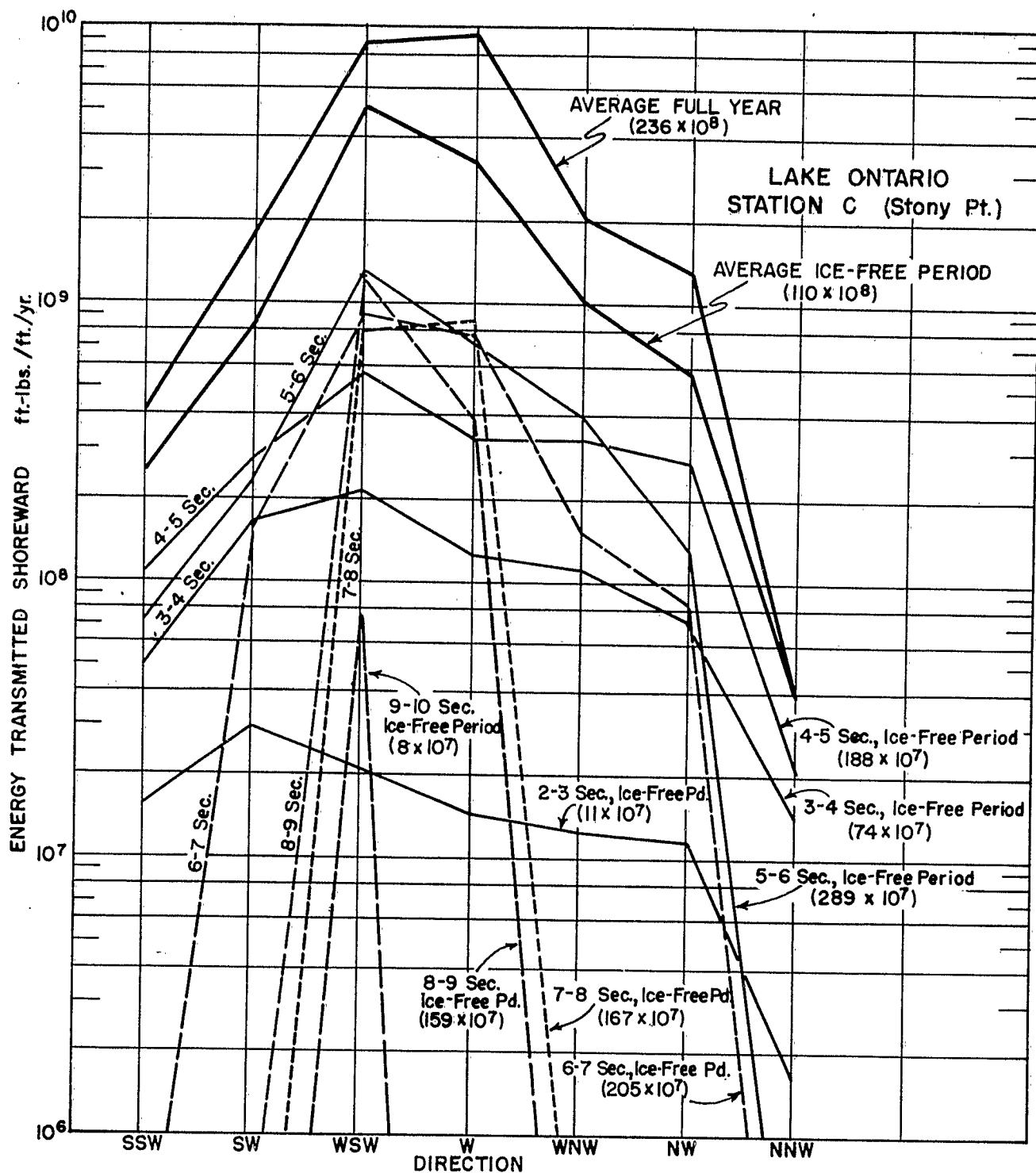


FIG. C-1





AVERAGE AMOUNT OF ENERGY TRANSMITTED SHOREWARD PER FOOT OF CREST LENGTH PER YEAR, IF WAVE SYSTEM IS CONSIDERED AS AN HYPOTHETICAL UNIFORM SYSTEM COMPOSED OF WAVES OF SIGNIFICANT HEIGHT AND PERIOD ONLY

FIG. C-4

D71031